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Conseil Permanent International pour l'Exploration de la Mer

CHARLOTTENLUND SLOT — DANEMARK

ANNALES BIOLOGIQUES

VOLUME NO. XV

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Á. FRIÐRIKSSON

1958

En Commission chez

ANDR. FRED. HØST & FILS

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Février 1960

Scheme for the Arrangement of the Material

I. Review of Investigations and Essential Results

Each Committee Chairman should here give a summary of the contributions received, i. e., a statement of the nature of the material as well as a short review of the position in the area—including the main results obtained—during the last calendar year (unless otherwise stated). This review should only in exceptional cases exceed 2 pages (about 10,000 units of type). Papers should reach the General Secretary not later than 1. May.

II. Tables and Conclusions

A. Environment

1. Strength and direction of currents: Especially data collected during spawning seasons.

2 a. Temperature and salinity conditions: Tables and/or diagrams including anomalies.

2 b. Seasonal temperature variations at selected stations: Data including anomalies.

3. Phosphate concentration, oxygen, etc.: Tables and diagrams to include anomalies.
4. Plankton conditions: Tables and/or diagrams, especially anomalies in distribution of indicator forms, phytoplankton patches, amount of plankton and fat content.
5. Abundance of benthonic food: Data.
6. The main meteorological features of the year: Data especially as to sunlight, rainfall, and direction and force of the wind.

B. The Fish

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1. Abundance and distribution of eggs and larvae.
2. Abundance of year-classes: Data derived from experimental hauls.
3. Size- and age-composition of commercial catches or landings.
4. Average length of age-groups: Data from experimental hauls and commercial catches, with standard deviations.
5. Rate of growth: Data from marking experiments and quantitative experimental hauls.
6. Rate of mortality: Data from marking experiments and quantitative experimental hauls.
7. Intensity of fishing: Data as to the fisheries considered in 3, 4, and 8.
8. Quantities landed:—
   (a) Total catch (weight) of special fisheries.
   (b) Percentage of large, medium, and small.
   (c) Total number of the various species.
   (d) Size- and age-composition of commercial catches or landings.

C. Shellfish

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PREFACE

In the past some dissatisfaction has been noted as to the rather confused arrangement of the contents of the *Annales Biologiques*. Each of the latest volumes has contained nearly 100 articles. Articles on hydrography, plankton, and benthos have been dispersed in the four area sections. With due regard to this fact, the Editorial Committee found it worthwhile to try a new arrangement by collecting all data on hydrography in one section, all contributions dealing with plankton and benthos in another, and the fish species, outside those which are dealt with in the subject committees, in a third section; the remainder of the Annales is unchanged. It is hoped that this rearrangement will be generally appreciated. In the summaries by chairmen of area committees surveys of the conditions in the various areas are given.

As to the *hydrographical conditions* the following points should be noted. On the West Greenland banks the temperature was a little below normal but the south-going Irminger Current off East Greenland had a greater extension than observed for many years. At Iceland the Atlantic water in the uppermost 100 metres was considerably less predominant than during recent years, especially off the north coast in early summer. This applied also to the area between Iceland and Jan Mayen.

In the Near Northern Seas area temperature and salinity conditions seem on the whole to have been about normal but, generally, the temperatures were relatively high during the first half of the year and relatively low in October/December.

The information on *cod* refers to West and East Greenland, Iceland, Barents Sea, and Baltic. On the offshore banks of West Greenland the fishery depended on the same year-classes as in 1957. The older year-classes (1947 and 1950) had decreased considerably as compared with 1957 but the 1953 class had increased. At East Greenland the 1942, 1945, 1947, and 1950 year-classes were predominant, and in the spawning population at Iceland, four strong broods occurred (1951, 33.0%; 1950, 25.8%; 1945, 11.7%; and 1949, 10.1%), in all 80.6% of the total catch. In the Barents Sea great changes seem to have taken place, beginning with a sudden drop in the yields about the middle of 1956. It is suggested that the disastrous decline of the stock may be explained, at least partly, through decreasing temperatures. There was less old and more young fish present in the Baltic in 1958 than in 1957 and there is some evidence for the 1957 year-class being very strong.

On *haddock* information is presented from the Barents Sea, the Faroe area, and the North Sea. In the Barents Sea the 1950 and 1953 year-classes remained predominant as in previous years and a considerable number of two year-old fish were also present (1956 year-class). The catch per unit of effort remained low as has been the case since 1956. The Scottish catches of Faroe haddock consisted mainly of young fish (age-groups II—V), and for the first time since 1952, a decrease in the total weight per 100 hours' fishing was noted. The 1955 year-class was still predominant in the North Sea and the 1957 year-class was above normal. The 1958 year-class seems to be moderate. The German investigations indicate that the mean catch per unit of effort has strongly decreased, at least in certain areas of the North Sea.

In respect of the *whiting* the broods of 1955 and 1957 (German catches) were predominant in the North Sea. As to the whiting in the western Baltic, reference is made to the contribution by KÄNDLER (p. 123).

In the section on *herring* a great deal of information is given on stocks from various grounds. The winter fishery at Norway and the summer fishery off the north coast of Iceland gave poor yields but in the North Sea relatively good catches were obtained in the northern part of the sea, whereas the East Anglian fishery yielded less than ever. It is of particular interest to note the increasing yields from the Dunmore area where considerable spawning took place in January (see p. 155). It is hoped that future investigations will increase our knowledge of this stock and its relations to other stocks of herring.

The reader's attention should be drawn to the *Statistical News Letters* Nos. 7 and 8. In No. 7 there are detailed records on the North Sea herring in 1958, whereas No. 8 contains information on cod, haddock, whiting, plaice, and sole — mostly from the North Sea. There is also information on size distribution of redfish from all the redfish areas and, finally, there is a paper dealing with German investigations on commercial saithe landings in 1958/59.

My best thanks are extended to chairmen and contributors, but I am especially indebted to Mrs. H. HARDER of the Central Office and her assistant, Mrs. M. LARVIG, for their unremitting work in the preparation of the volume.

ÁRNI FRIÐRIKSSON

CHAIRMEN'S SUMMARIES OF AREA REPORTS

Distant Northern Seas

Contributions to this report have been received from:—

Denmark:
P. M. Hansen
F. Hermann
J. Smed

Germany:
C.-H. Brandes
A. Kotthaus
G. Krefft

Iceland:
I. Hallgrímsson
J. Magnússon
U. Stefánsson
Th. Thorðardottir

Scotland:
J. H. Fraser
J. M. Lamont
T. Lovegrove
B. B. Rae

I. Hydrography

The routine study of monthly anomalies of surface temperatures in the northern North Atlantic show that positive anomalies are still highly predominant, and with higher values than in 1957.

On the West Greenland banks the temperatures were somewhat below normal. The arctic component of the West Greenland Current, however, was weaker than usual and the Atlantic component was well developed.

The Atlantic water between the Faroes and the Reykjanes Ridge had decreased in thickness since 1957 but west of the ridge the north-going Irminger Current had an extension similar to that observed in 1957. The south-going Irminger Current off the East Greenland slope had a wider extension than observed for many years.

The ice conditions on the Iceland-Greenland Ridge in June, were similar to those found in 1956 and 1957. In early summer, in Icelandic waters, the temperature of the uppermost 100 metres was below normal, especially off the north coast, where the amount of Atlantic water was markedly less than observed in recent years.

In the area between Iceland and Jan Mayen the temperatures of the uppermost 100 m were somewhat lower than observed in 1956 and 1957 and the extension of polar water greater.

II. Plankton

Measurements of primary production in Icelandic waters were made in May/June by means of the ^{14}C technique; the highest values were found off the west coast. High rates of production were also found off the western part of the north coast, whereas the area off the eastern part of the north coast, the east coast, and the area between Iceland and Jan Mayen showed a low rate of production. The mixing area outside the east Icelandic shelf had a high rate of production.

The density of zooplankton in the uppermost 50 m layer in Icelandic waters is shown for the years 1951, 1956, 1957, and 1958. A remarkable feature in the distribution is the tongue of high zooplankton concentration which penetrates from the Irminger Sea to the south-west coast of Iceland. The youngest stages of *Calanus finmarchicus* are encountered in this area. The older stages and mature females are present in the waters off the north coast. Compared with previous years, only poor concentrations of zooplankton were found in Icelandic waters in 1958.

Scottish plankton data suggest that less Atlantic water affected the Icelandic area than in 1957. In the early part of the year, there was some evidence of boreal influence in the deep waters across the Iceland-Faroe Ridge but much less in the autumn. The waters around the Faroes were little affected by oceanic inflow. In September, Atlantic species west of the British Isles extended towards the Faroe-Iceland Ridge and, in autumn, the Lusitanian fauna entered the Faroe Channel and spread along the slope of the continental shelf to the north of Scotland.

III. The Fish

A Danish report deals with tagging of halibut at East Greenland and of redfish at West Greenland.

An Icelandic report is given on the length distributions of redfish from new fishing grounds off the Labrador coast. In the northern part of the area investigated (Hamilton Inlet Bank) the redfish were mainly of the *mentella* type. Farther south they were mixed with the *marinus* type. Different types of length distribution occurred repeatedly at the various stations. This phenomenon has also been observed for other regions and indicates that redfish form distinct shoals with different age distribution.

Finally there is a list of rare fishes from the Distant Northern Seas area, collected during the year.

Jón Jónsson

Near Northern Seas

Contributions to this report have been received from:

Denmark:
K. P. Andersen
AA. J. C. Jensen
J. Smed
H. Thomsen

Germany:
G. Koopmann
G. Krefft
H. Mann
P. F. Meyer-Waarden
E. Rogalla
E. Ziegelmeier

Norway:
O. Aasen

Scotland:
B. I. Barnes
R. B. Burns
R. E. Craig
J. K. Fraser
R. S. Glover
R. Johnston
J. M. Lamont
T. Lovegrove
B. B. Rae

Sweden:
A. Svansson

I. Hydrography

Again, the Danish research vessels "Dana" and "Jens Væver" collected a considerable amount of hydrographic information in the Near Northern Seas area. In the Bløden area, so important for the industrial fishery, temperatures in the deeper water layers appeared to be rather low in spring and early summer. Late in the year water temperatures were, on the other hand, somewhat higher than normal, but with minimum figures exactly in the Bløden area.

In May and June the R-section revealed a clear-cut temperature stratification, but late in November this body of water was remarkably uniform in temperature from surface to bottom. Strong winds appeared to affect the temperature pattern. Salinities did not reveal anything unusual along the R-section.

The research vessel "Scotia" made several series of observations, off the Scottish east coast and in the Shetland waters. Both temperature and salinity conditions came so close to the long-term means for these waters, that no special remarks need be made. Evidence from drift indicators suggests an abnormally slight circulation.

Observations made by the "Anton Dohrn" in mid-summer reveal the presence of two bodies of water in the central and northern North Sea, i.e., the North Sea water *sensu strictu* (34.0—35.0‰), situated east of the Atlantic water, and the coastal water, east of Helgoland (30.0‰).

A typical summer stratification was observed in the Dogger Bank area, a clear-cut thermocline included. The observations suggest that the turbulence produced by strong tidal currents tend to compress the thermocline over and south of the Dogger Bank.

A special series of observation was made by the "Anton Dohrn" in October, covering the Dogger Bank area. The spread of the water masses of different origin was revealed by the salinity pattern. At that time of the year a marked stratification, with a clear-cut thermocline, could be observed north and south of the Dogger Bank, whereas in the shallower parts of the Dogger Bank and German Bight no such stratification was observed, though it did occur here earlier in the year. The bottom water temperature was in October only 6°C north of the Dogger Bank, and below 9°C south of the bank. Due to a gale the 12° isotherm was in mid-October displaced from north of the Dogger to 40 miles towards the German Bight.

Danish observations of surface temperatures of the eastern coast of Scotland reveal that positive anomalies are still predominant there.

Observations made from German lightships reveal that surface temperatures were rather low in the German Bight in the first half of the year, about normal in mid-summer, and above normal in the last four months of 1958. Salinities fluctuated around the usual values at lightship "P 8" only; elsewhere in the German Bight salinity values were rather low throughout the year, the month of September excepted.

The thermograph recordings made in the North Minch tally with the observations in the German Bight. Here too, the first half of the year was rather cold, whereas values above the averages were observed in the period from September to November.

The same holds good for the Danish and Swedish observations in the Kattegat: rather low water temperatures in the earlier part of the year, and fairly high values in autumn. Surface salinities measured simultaneously indicate again a strong influx of Baltic water, especially in June and September.

Of considerable interest are the Scottish data on the content of oxygen and phosphates. In November/December 1957 oxygen values were locally rather low which is explained in terms of winter overturn. Phosphates revealed at that time a noticeable winter recovery. No synoptic oxygen and phosphate charts could be presented for the first months of 1958, but the western side of the northern North Sea was well covered in July 1958. The high oxygen saturation observed at that time in the Shetland-Orkney waters is explained in terms of a protracted phytoplankton development. The most remarkable feature of the observations made in 1958 is the occurrence of a large area of high phosphate figures (over 0.5μg-at. PO_4/P per litre), indicating an early

winter overturn. The oxygen values recorded in early winter 1958 were rather similar to those found in the corresponding part of the preceding year.

II. Plankton and Benthos

Plankton investigations were continued from Aberdeen. Again, the more dominant species of phytoplankton organisms are mentioned. As a whole the phytoplankton outbursts in spring and autumn differed neither qualitatively nor quantitatively from those of an average year.

The zooplankton studies revealed a rich *Calanus* population in the northern North Sea in spring. A marked influx of Atlantic fauna penetrated the Faroe Channel in early summer, but did not penetrate into the North Sea until after July, then affecting large areas of the northern North Sea and reaching the Norwegian coastal area in November. Of considerable interest was a tongue of water carrying a Lusitanian fauna, penetrating into the Faroe Channel in November. Interesting cases of demersal fish feeding on zooplankton organisms are reported.

Again considerable information was collected with the Continuous Plankton Recorder. With some minor exceptions the usual routes could be covered in 1958. Additional samples were taken by "Explorer" and "Sarsia". Though the data thus obtained resemble those for 1957 in many respects, it should be noted that many events occurred one or two months later in 1958 than in 1957. Moreover plankton studies corroborated the hydrographical evidence that penetration of oceanic and western coastal water into the North Sea was decidedly less than in the years 1952—1954, and came furthermore later in the season.

On the Scottish east coast herring fishing grounds the shelf-plankton dominated again, with a relative scarcity of extreme neritic and oceanic plankton. This condition has been observed here since 1955, in marked contrast to earlier years.

The bottom fauna investigations in the eastern part of the German Bight have been continued in 1958. The salient points of the findings were a remarkable similarity of the figures for the total biomass per unit of surface for spring and autumn. The lamellibranch stocks did not rise at all in the course of the year, and polychaetes revealed a limited increase only. The total figures for lamellibranchs and polychaetes in autumn 1958 fell far short of those in autumn 1957. Severe winter weather could not be held responsible for this phenomenon. Lamellibranch enemies like *Lunatia nitida* reached peak values late in 1958. In the polychaetes it was especially *Spiophanes bombyx* which showed a remarkable reduction in its numbers to about 10% of the 1957 values. Young specimens of *Lanice conchilega* were on the other hand rather numerous in 1958. *Echinocardium cordatum* continued its come back after the severe winter of 1955/56; about 95% of the stock found in autumn 1958 measured about 10 mm.

III. The Fish

Plaice

The German plaice investigations were continued in 1958; for technical reasons the data obtained will be published in the *Annales Biologiques* for 1959.

The Danish plaice investigations revealed the presence of great numbers of 0-group plaice in the coastal waters of the Skagerak. In the shallow parts of the northern Kattegat this year-class was about 50% greater than normal though not nearly so strong as the unusually abundant 1957 year-class. Contrary to the expectations roused by the exceptionally strong 1957 year-class the strength of the I-group amounted to only the double in the northern Kattegat. No doubt migration is the cause of the discrepancy.

In the coastal waters of the southern Kattegat the 0-group was about three times the normal, and the I-group was stronger here than could have been expected from the 0-group in 1957. Here also it was migration which complicated the picture.

Investigations in deeper water revealed a noteworthy increase of I-group plaice between June and November, due to immigration from the central Kattegat. The plaice at the southern entrance to the northern Kattegat appeared to belong to the North Sea race, whereas admixture with the Belt Sea plaice could be demonstrated for the more southerly sections. The plaice fished in July off Mariager fjord appeared to belong predominantly to the Baltic race. In November, on the other hand, the stock had changed completely here through admixture with North Sea plaice.

Analysis of commercial catches corroborated the observations made from the research vessels. Indeed, the northern Kattegat must have received almost all the small plaice migrating from the central Kattegat.

Dogfish

Norwegian investigators tagged some 1000 spiny dogfish. The recaptures led to construction of migration routes.

Eel

Of considerable interest are the results of an eel tagging programme carried out in Germany. The

recapture of two eels in Danish coastal waters suggests that the Elbe eels migrate to the Atlantic along the Danish coasts and around Scotland. Since very little was known thus far on the eel's migration routes, this contribution is very welcome, indeed.

Industrial fishery

Again, data are presented of the German sand-eel fishery. Several samples of sand-eel have been analysed. The average length increased from 13.0 cm in May to 18.7 cm in July. The industrial catches consisted almost exclusively of *Ammodytes lancea marinus*.

Rare fishes

A number of rare fishes encountered in the Near Northern Seas area is listed.

P. Korringa

Baltic-Belt Seas

Contributions to this report have been received from: —

Denmark:
O. Bagge
Aa. J. C. Jensen
H. Thomsen

Germany:
G. Koopmann
R. Kändler

Poland:
J. Filarski

Sweden:
A. Svansson

U. S. S. R.
M. S. Kireeva
I. Nikolaev

I. Hydrography

In Great Belt ("Halsskov Rev" lightvessel) where observations are failing in the period May/July, and in the western Baltic the surface salinity was mostly below normal. In Great Belt values above normal were observed especially in October/December, at "Fehmarnbelt" and "Gedser Rev" especially in October. The low values correspond to an extraordinary frequency of eastern winds partially also to a heavy precipitation in the winter of 1957/58.

At the southern Swedish lightvessels in the Baltic the surface salinity was mostly above normal until May or June but below normal in the remainder of the year. At Christiansø the salinity was above normal throughout the year as was also the case at the northern Swedish lightvessels in the period June/December, only few observations being available for January/May.

In a contribution on plankton Nikolaev mentions that the discharge of fresh water into the Gulf of Riga in the winter and spring of 1958 was very much above the normal value. The strong winds prevailing during the first half of the year must have counteracted dilution of this discharge thus causing the relatively high surface salinity values. The bottom salinity in Great Belt and at "Fehmarnbelt" and "Gedser Rev" lightvessels was low in the period January/April and unusually low in March; at "Gedser Rev" it was also below normal in the period May/August (observations for "Halsskov Rev" are not available for the period May/July). At "Halsskov Rev" and "Gedser Rev" the bottom salinity was high in September/December, whereas at "Fehmarnbelt" it was above normal in May, June, and October, but below or nearly normal in the other months.

At the Swedish lightvessel in the Sound ("Oskarsgrundet") the bottom salinity was above normal in January, April, May, and October (March unknown). The winter and spring values did not indicate inflows of saline water into the Baltic. It is not unusual that saline water from the Kattegat pass the Sound but is immediately washed out again. Filarski and Svansson state that no renewal of the water in the Bornholm Deep and the more eastern basins took place until November and October respectively. On the other hand, the high bottom salinity in October (also observed in Great Belt and the western Baltic) indicated an inflow of saline water. According to Filarski it was observed in the Arkona Deep already in November and between November 1958 and January 1959 this saline water had reached the Bornholm Deep and, in February 1959, the Gdansk Deep.

As the Swedish lightvessels in the Baltic are placed at low water levels the bottom salinity there does not registrate an inflow into the Baltic; they show on the whole only small anomalies which follow those of the surface water.

The surface temperatures in the area considered were below normal from January or February until June/August. In the remainder of the year they were mostly above normal.

At the bottom the low temperatures prevailed in Great Belt and at "Fehmarnbelt" until September, at "Gedser Rev" lightvessel the temperature was, however, above normal in July and August. During the last months of the year the bottom temperature was mostly above normal. The low temperatures in the first half or three quarters of the year were due to the cold winter and spring. Owing to inflow of saline water during the last quarter of the year the temperature in the deeps of the Baltic proper rose to above normal. Filar-

SKI reports that during the last months of the year the temperature in the intermediate water layers of the central Baltic rose without any perceptible rise in salinity.

II. Plankton and Benthos

According to NIKOLAEV the amount of zooplankton present in the eastern part of the central Baltic was below normal in the first half of the year on account of the low temperature of the water. In the second half of the year the quantity was above normal but the composition of species was abnormal owing to the low salinity. In the Gulf of Riga the amount of plankton was above normal in May already because the discharge from the rivers had been 150% of the normal in the period January/April.

The distribution and quantity of *Furcellaria fastigiata* near the eastern coast of the central Baltic has been investigated by KIREEVA. The amount produced is sufficient for commercial exploitation, the growth of *Mytilus* on *Furcellaria*, however, suppresses to some extent its growth.

III. The Fish

The quantity of cod and sprat eggs observed at the "Fehmarnbelt" lightvessel in the period December 1957 to August 1958 was very much less than normal, and that of flounder and dab was about half the normal. Cod eggs are on an average found from December to June but they are most plentiful in February/April with a maximum of 81 per m² in February; but in 1958 spawning was delayed and the first few eggs were observed in February and the maximum, 17 per m², occurred in May at a time when the average number is only 3 per m². The season for eggs of plaice, flounder, and dab was delayed about one month. KÄNDLER explains the sparsity of cod and flatfish eggs by the low temperature of the water. The few sprat eggs present tally with the scarcity of adult sprat in these waters. Mackerel eggs were, on the other hand, more frequent than normally, but as usual no larvae were found.

The number of 0-group plaice present on the coasts of the Belts and the Sound seems to have been about twice the normal one, but on the Danish coasts of the Baltic proper it was below normal. I-group fish occurred in relatively great quantities in accordance with the many 0-group plaice found in 1957. 0-group sole were more plentiful in the Sound and on the Baltic coast of Seeland than normally. The stock of plaice in the open Belt Sea was on the whole more sparse than in 1957. The rich 1955 year-class was reduced in numbers and the 1956 and 1957 year-classses dominated the stock. The 1957 year-class was rich and its recruitment of fish over the Danish size limit (26 cm) gave at some places a rise in the yield of the fishery already at the end of 1958; in a Danish commercial catch taken in the northern Belt Sea this year-class was, however, scarcely represented.

In the Sound relatively large and old plaice were more frequent than in other waters on account of trawls and seines being prohibited there.

In the western Baltic the density of the stock was on the same low level as in 1957 and the 1957 year-class seemed to be scarce there.

At Bornholm groups II and III plaice dominated the stock.

The 1955 year-class of flounder dominated the stock in the western Baltic at the relatively great depths where the fishery is carried out.

According to BAGGE the total number of dabs caught per hour in the Belt Sea was about the same as in 1957 but lower than in 1955 and 1956 when the stock was dominated by the large numbers of small fish of the rich year-classes. In 1958 the largest numbers of dab were taken in the northern Belt Sea. Dabs over the size limit (25 cm) were more plentiful in the Sound than in other waters. In the western Baltic the average length of dab was a little higher than in the Belt Sea and age-groups II and III were predominant. At Bornholm dab was as usual very scarce.

Long rough dabs of age-groups I/III were caught by German trawls in the western Baltic where they do not spawn.

The Danish forecast of the yield of silver eel is reported. Eels with tumour disease have been encountered in fresh water at several places.

AAGE J. C. JENSEN

PART I.

HYDROGRAPHY

A. Distant Northern Seas

Monthly Anomalies of the Surface Temperature in Areas of the Northern North Atlantic in 1958

(Figures 1–3; Tables 1–2)

On the basis of data collected in 1958 by the Danish Meteorological Institute from Danish and Icelandic ships in the northern North Atlantic anomalies of surface temperatures have been evaluated for each month and each 1°-square, using RYDER'S grand monthly means for the period 1876—1915 as standards. These anomalies were then averaged over the areas indicated in Figure 1.

The results are given in Table 1, where the monthly anomalies are recorded, together with the numbers of observations on which they are based. In the last column of the table the monthly anomalies for each area have been averaged for the year.

Table 1 shows that positive anomalies are still highly predominating. Thus for all areas the yearly averages of monthly anomalies are positive, as seen from the last column of Table 1. The distribution of these yearly anomalies over the region is shown in Figure 2. Evidently, the anomalies, as in 1957, are highest around Iceland and east of South Greenland.

The average of the yearly anomalies given in the last column of Table 1 is 0.8°C, which is 0.1°C higher than in 1957. Figure 3 shows the geographical distribution of the variation of temperature

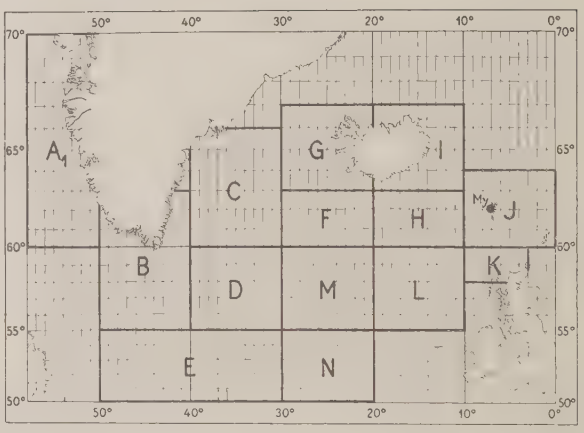


Figure 1. Location of areas A_1 to N and of Station My.

Table 2. Grand monthly means of the surface temperatures (°C) at Myggenæs, Faroes (My in Figure 1) during the period 1914—1950 and deviations for 1958 from these means

	Jan.	Feb.	March	April	May	June
Means 1914–50	6.3	6.0	5.9	6.3	7.1	8.2
Deviations 1958 ..	–0.6	–0.7	–0.6	–0.2	–0.5	–0.4

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Means 1914–50	9.3	9.8	9.7	9.1	7.9	7.0	7.7
Deviations 1958 ..	–0.2	–0.3	0.4	0.5	0.8	0.5	–0.1

Table 1. Monthly anomalies (△ °C) and numbers (n) of observations of the surface temperature in the areas A_1 N (see Figure 1) during 1958

	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Aver.
	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	△	n	of △-val.
A_1	—	—	—	—	–0.5	2	0.2	34	0.7	95	0.9	95	1.0	138	1.0	109	0.8	78	0.7	61	0.8	5	—	—	0.6
B	—	—	—	—	–0.7	35	0.0	104	0.7	96	0.9	113	0.9	105	1.4	141	1.1	80	0.0	84	0.2	53	–2.0	5	0.2
C	—	—	—	—	1.0	12	1.1	44	0.8	50	1.5	52	2.7	74	2.8	79	1.5	54	1.0	45	–0.1	4	1.0	1	1.3
D	1.3	24	0.1	6	0.6	43	0.6	86	0.8	64	1.4	57	1.6	40	1.9	41	1.4	32	0.3	44	0.2	38	0.8	17	0.9
E	0.7	122	1.1	34	2.0	39	0.4	23	1.1	66	1.3	69	0.9	57	0.8	86	1.2	43	–0.9	74	–0.2	72	–0.6	43	0.6
F	–0.8	5	1.0	3	0.8	13	0.7	99	0.5	59	1.0	65	1.6	76	1.1	55	1.6	34	1.3	40	0.3	37	0.3	7	0.8
G	0.6	5	1.9	8	1.1	9	0.8	13	0.8	17	1.8	18	1.6	21	0.6	26	2.0	24	0.8	19	1.5	16	1.9	15	1.3
H	0.8	40	0.7	64	0.6	63	0.6	136	0.2	92	0.4	111	0.9	114	0.7	101	1.8	67	1.2	77	1.1	70	1.3	48	0.9
I	0.9	12	1.0	10	0.6	17	0.4	9	1.2	17	1.3	8	1.9	17	1.2	23	2.3	16	2.4	14	2.3	14	2.3	11	1.5
J	0.7	35	0.6	57	0.3	54	0.3	72	0.3	64	0.4	72	0.6	107	0.1	84	1.4	49	1.3	52	1.2	65	1.4	38	0.7
K	0.2	48	0.0	42	–0.2	52	0.1	73	–0.1	51	0.1	80	0.5	43	0.6	45	1.7	43	1.2	49	1.4	53	1.1	31	0.6
L	0.4	66	1.0	47	0.7	66	0.7	65	0.2	41	0.2	76	1.4	29	1.2	42	1.8	36	0.8	50	1.0	46	0.8	43	0.9
M	1.1	67	1.3	48	0.5	70	1.0	77	0.6	47	0.6	81	1.5	39	1.2	43	1.6	40	0.1	63	0.6	55	0.3	48	0.9
N	—	—	—	—	–0.3	2	0.5	6	0.2	14	–0.6	8	—	—	1.6	14	—	—	1.8	3	—	–	–1.9	2	0.2

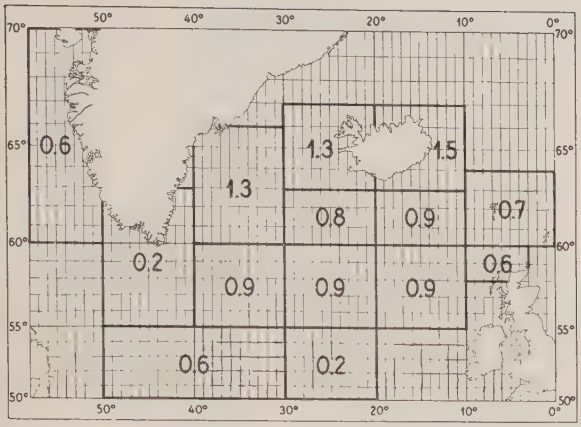


Figure 2. Anomalies of surface temperature (°C) for 1958.

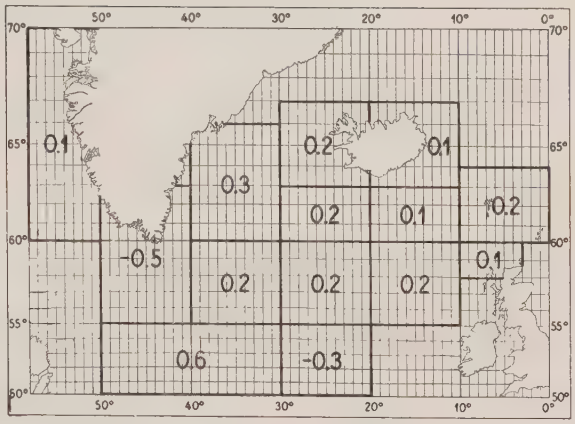


Figure 3. Variation of surface temperature (°C) from 1957 to 1958.

from 1957 to 1958. It appears that there is a tendency towards higher temperatures over the whole region, excepting an area at the southern limit of the region considered and an area immediately to the south of Greenland.

Table 2 gives the grand monthly means of the surface temperature at Myggenæs, Faroes (Station My in Figure 1) for the period 1914—1950, together with the deviations of the 1958 values from these means.

I am indebted to Messrs. I. Sestoft and H. Thomsen of the Danish Meteorological Institute for placing the data at my disposal.

Jens Smed

Correction

The unit used in *Annales Biologiques*, Vol. XIV, p. 14, Figures 3 and 4, is 0.1°C, not a whole degree as said in the legends.

Hydrographic Conditions in Icelandic Waters in May—June, 1958

(Figures 4–10)

The Icelandic research vessel "Ægir" made a hydrobiological survey in Icelandic waters from 19. May to 13. June. Figures 4—6 show the location of the stations worked and the distribution of temperature and salinity at 20, 50, and 100 m.

The ice conditions this year on the Iceland-Greenland Ridge were similar to those of June 1956 and 1957. Off Cape Horn on the north-west coast, the distance to the ice border was 20—30 nautical miles.

In most of the area investigated, the temperature in the surface layers was considerably lower than observed in June last year, especially in the Húnaflói region. This must be due to an intrusion of cold surface water from the north, cooling and diluting the east-flowing Irminger water. In such a mixing area, ideal conditions for plant production would be expected. An exceptionally active plant production in this area was also indicated by the percentage saturation values of oxygen in the surface layers. In the eastern part of the north Icelandic coastal area, the temperature was distinctly higher than in the western part. Comparison with previous years reveals that the temperature at 20 m was lower in June this year than it was in 1954, 1955, and 1957 but similar to what it was in 1956. This difference may partly be caused by the varying observation time, since this year's investigations, as well as those in 1956, were carried out a week or two earlier in the season.

In the oceanic area between north-east Iceland and Jan Mayen, the temperature of the surface layers was similar to that of 1956 and 1957. However, the core of the East Icelandic Current appeared very clearly as a narrow tongue of cold water in the region north of Slétta. In the region east and south-east of Langanes, the conditions in the surface layers resembled those observed in 1956, except for the boundaries between the arctic and Atlantic water which this year were noticeably sharper than usually observed.

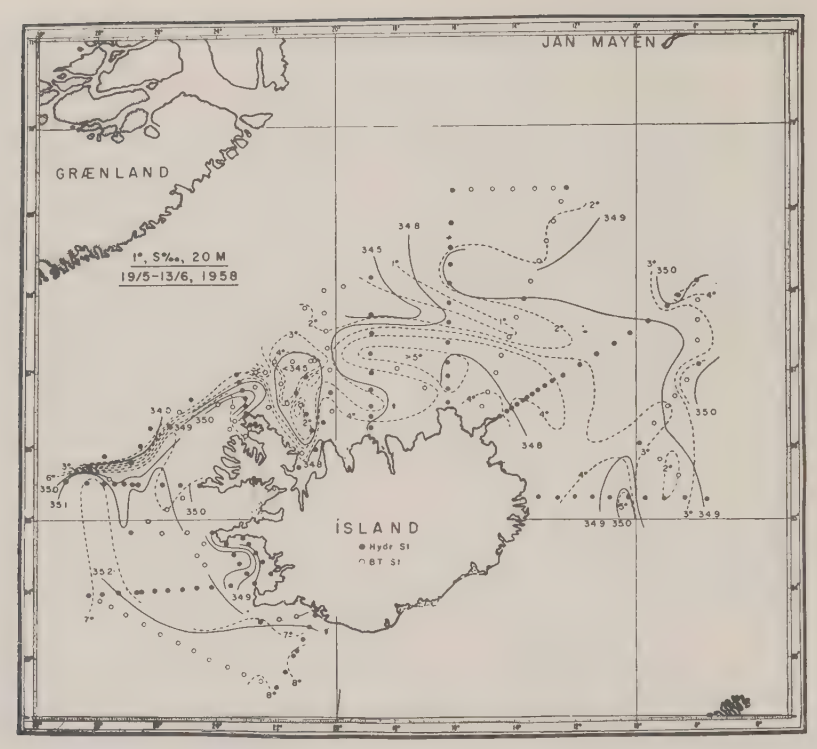


Figure 4. Temperature and salinity, 20 m, 19. May to 13. June 1958. Black dots indicate hydrographic stations, the circles BT stations.

Figure 5. Temperature and salinity, 50 m, 19. May to 13. June 1958. The symbols are the same as in Figure 4.

Figure 6. Temperature and salinity, 100 m, 19. May to 13. June 1958.
The symbols are the same as in Figure 4.

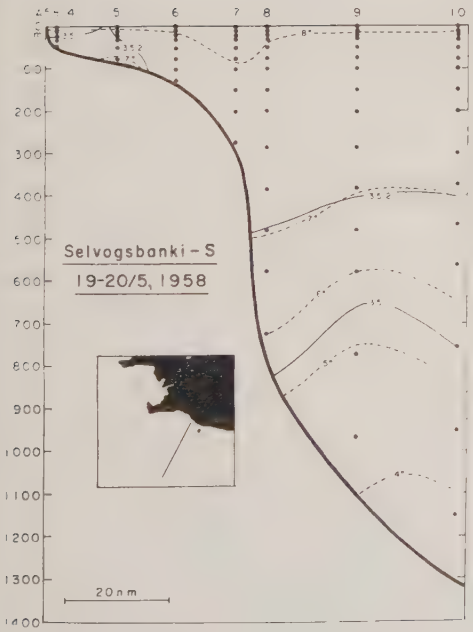


Figure 7. Section across the Selvogsbanki.

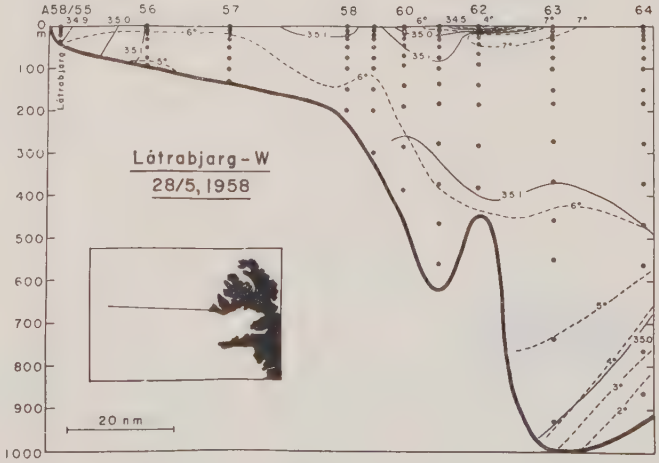


Figure 8. Section west of Látrabjarg.

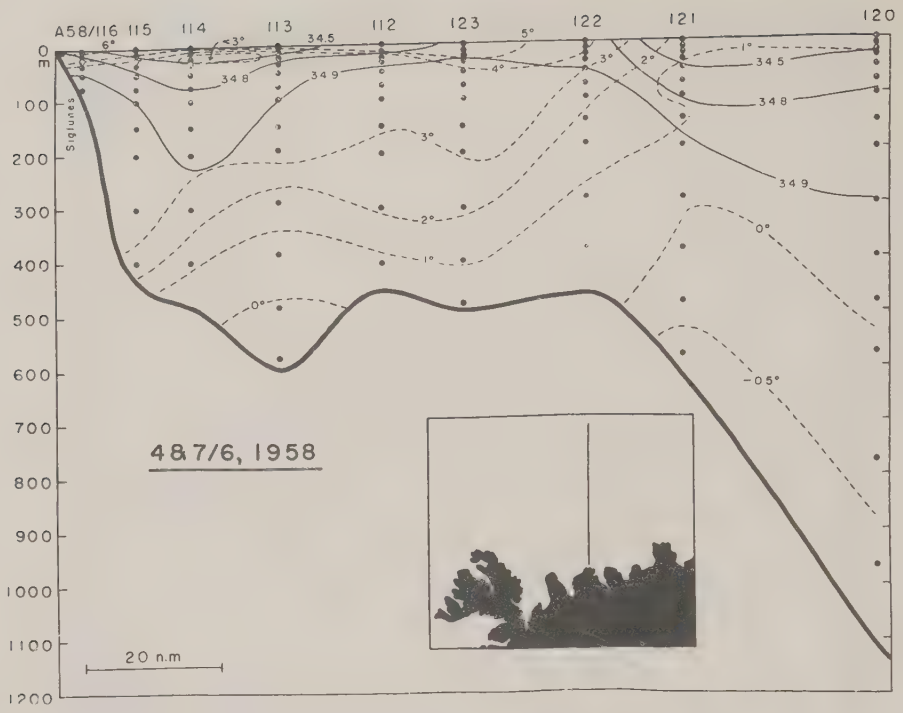


Figure 9. Section north of Siglunes.

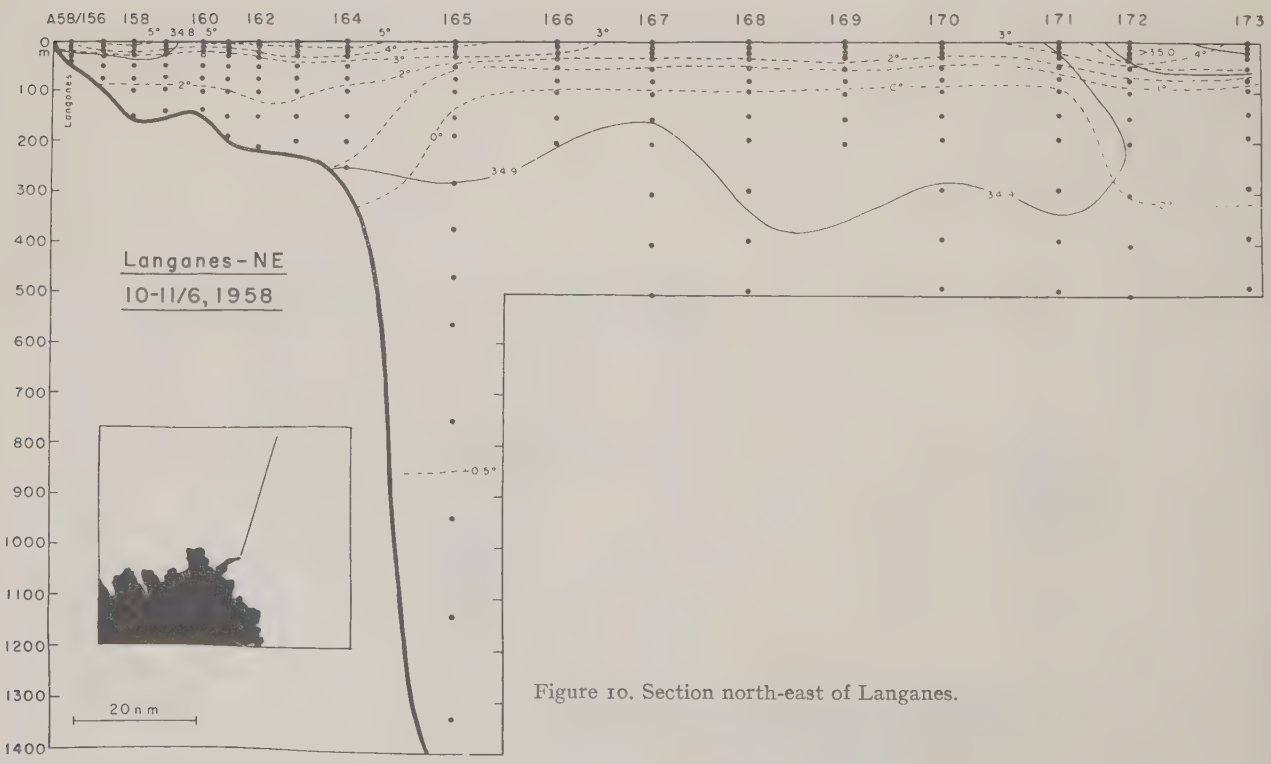


Figure 10. Section north-east of Langanes.

At 50 and 100 m, the temperature off the west coast was also similar to that of 1956. Off the north coast, however, it was about 1° lower than at the same time in 1956 and about 2° lower than one week later in 1957. In the oceanic area, the temperature at 50 m was lower than last year, but similar to what it was in 1956, whereas at 100 m the extension of polar water was greater than observed in 1956.

The hydrographic features are further illustrated by the vertical sections shown in Figures 7—10. The main features of the section off Selvogsbanki (Fig. 7) were similar to those found in 1957, but the temperature was at all levels somewhat lower in 1958.

The overflow of arctic water across the Iceland-Greenland Ridge (Fig. 8) appeared decidedly less than observed in early June 1957, but as has been pointed out, this process probably takes place intermittently.

Off the north coast (Figs. 9—10) the quantity of Atlantic water was markedly less than observed in recent years.

UNNSTEINN STEFÁNSSON

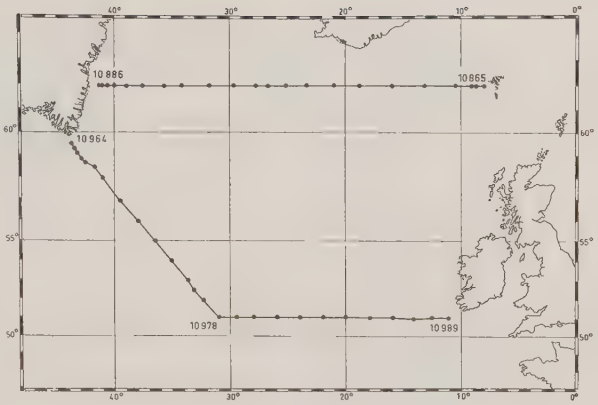


Figure 11. Location of sections.

Sections from the Faroes to East Greenland and Cape Farewell to Ireland

(Figures 11–13)

Two transatlantic sections were worked from R/V "Dana", the section along 62°N from the Faroes to East Greenland (Fig. 12) and the section from Cape Farewell to Ireland (Fig. 13 a and b.).

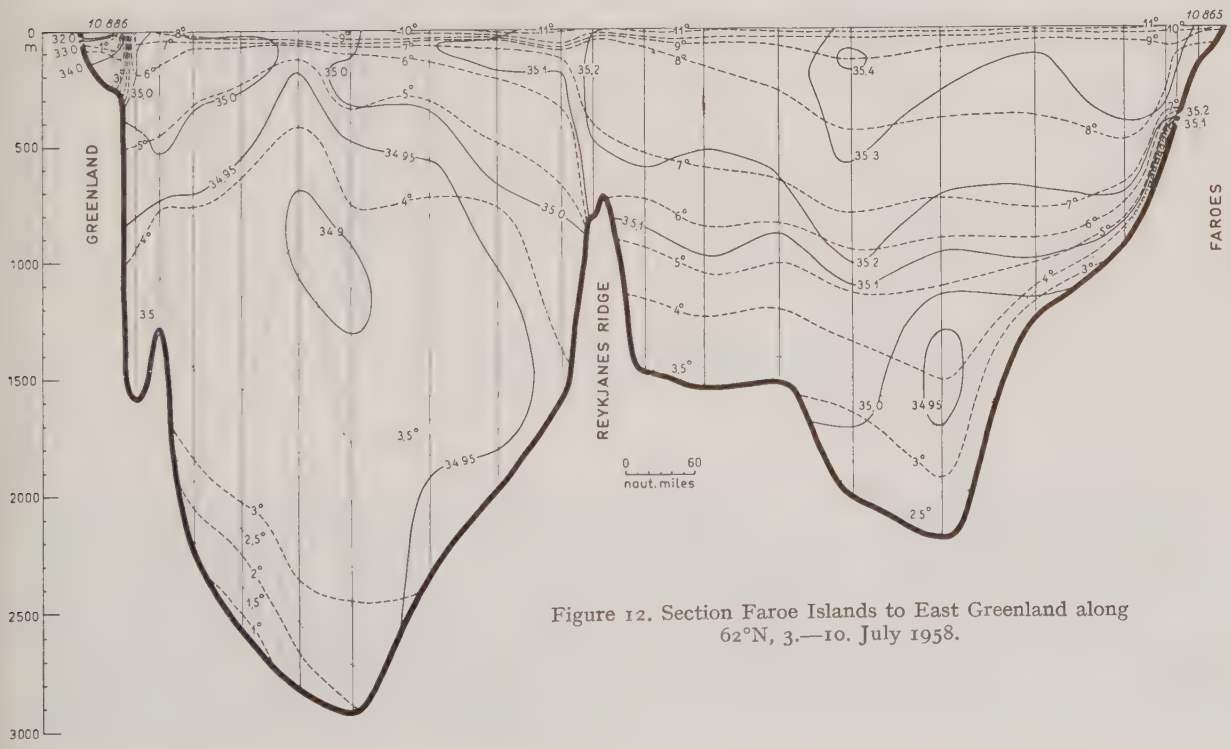


Figure 12. Section Faroe Islands to East Greenland along 62°N, 3.—10. July 1958.

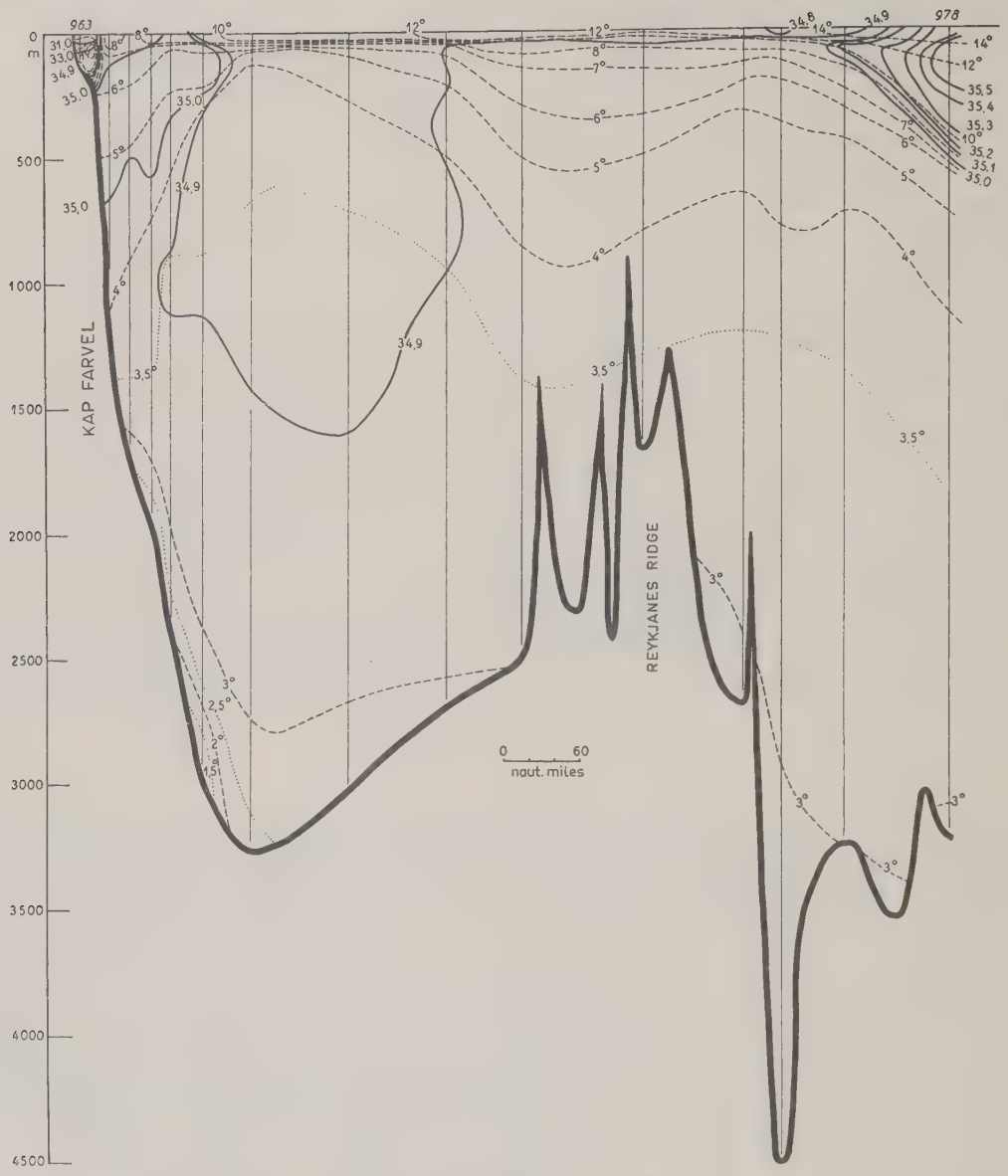


Figure 13a and b. Section Cape Farewell to Ireland, 15.—25. August 1958.

In the section from the Faroes to East Greenland the layer of warm Atlantic water found between the Faroes and Reykjanes Ridge had decreased considerably in thickness compared with the conditions found in 1957. On the slope off the Faroes and in the deeper part of the basin east of the Reykjanes Ridge the bottom water had temperatures below 3°C, which indicates overflow of deep water from the Norwegian Sea carried through the Faroe Bank Channel or the Faroe-Iceland Ridge.

West of the Reykjanes Ridge the north-going warm Irminger Current had a great extension just as in 1957. The south-going branch of the Irminger Current off the slope of East Greenland had a geater extension than observed in many years. Its

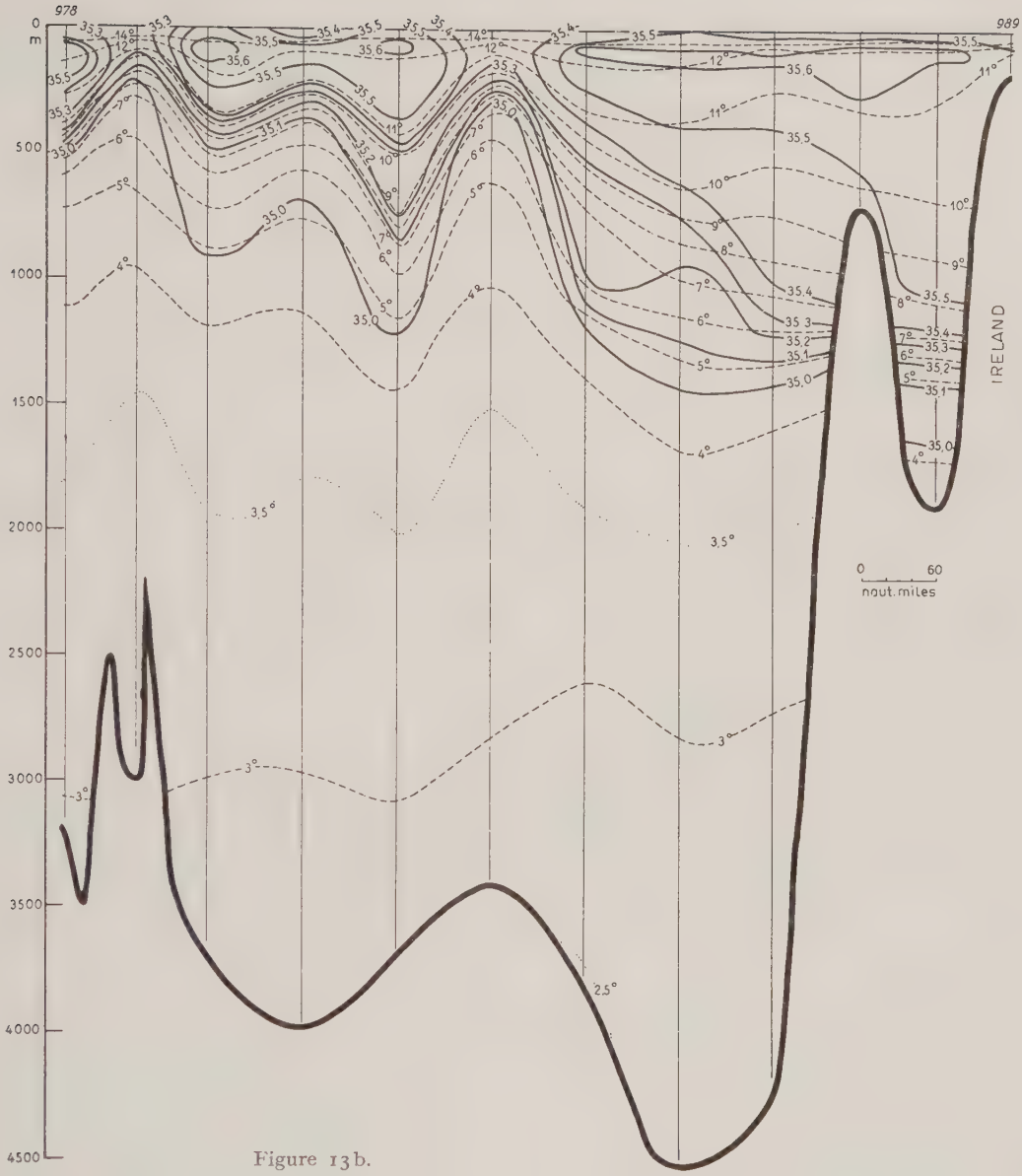


Figure 13b.

boundary to the East Greenland Polar Current was as usual very sharp and found at the edge of the Greenland Shelf. In the deep part of the Irminger Sea cold bottom water was observed, indicating a strong overflow of deep water from the Norwegian Sea over the Iceland-Greenland Ridge.

Off East Greenland in the section Cape Farewell to Ireland the same water masses were found as those described in the above section. Also here the Irminger Current was well developed and the Polar Current weak; no negative temperatures were measured here.

The front between the subarctic water masses from the Labrador Sea and the Atlantic water masses of the Gulf Stream system was observed at longitude 32°W, that is at approximately the same position as in previous years.

F. Hermann

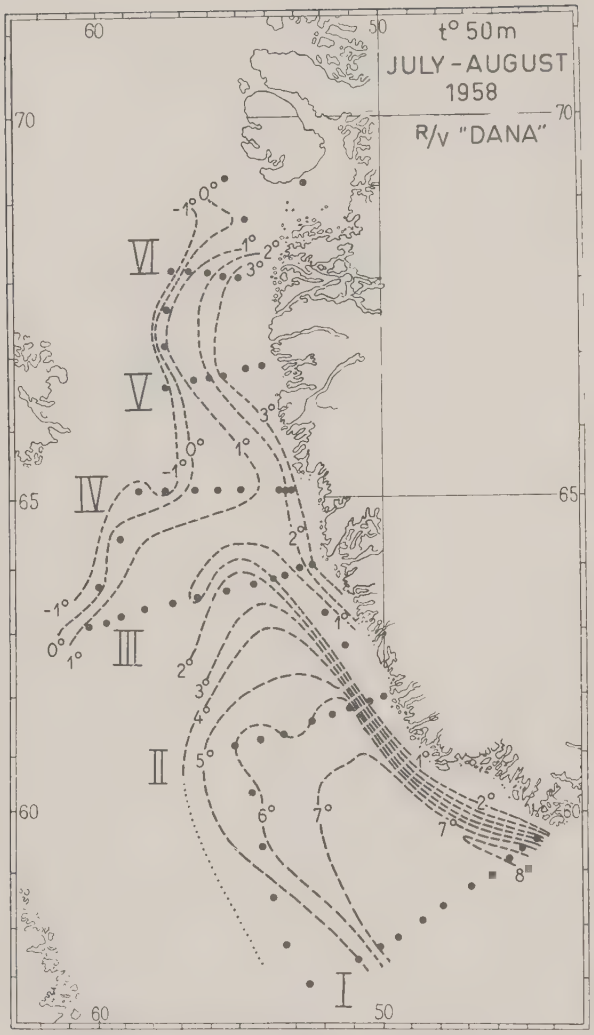


Figure 14. Location of sections and distribution of temperature at 50 m.

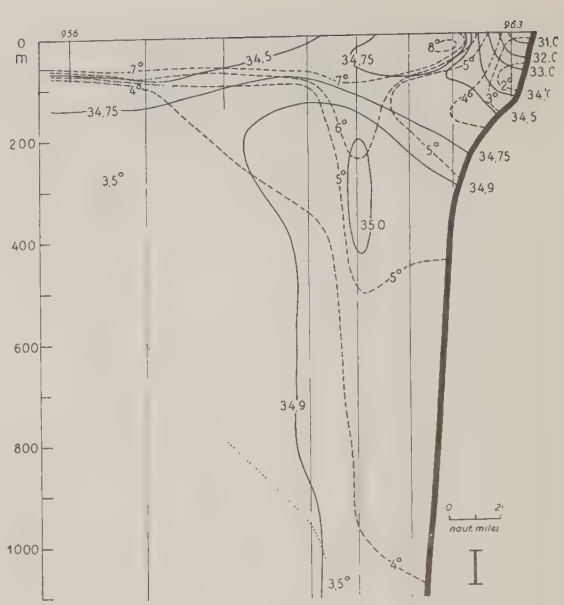


Figure 15. Section I off Cape Farewell, 13.—15. August 1958.

Hydrographic Conditions in the Eastern Part of Labrador Sea and Davis Strait in 1958

(Figures 14–21)

The sections I to VI shown in Figure 14 were worked with R/V "Dana" from July to August.

Figure 14 further shows the temperature distribution at 50 m. The sharp front between the arctic and the Atlantic component of the West Greenland Current is clearly seen in the southern part of the area.

Off Godthåb part of the West Greenland Current bends westward and later south-westward and meets the cold Labrador Current. Over the West Greenland banks the temperatures were a little below normal on Dana Bank and Fiskenæs Bank, but about normal from Fylla Bank northwards. In the area west of the banks the temperatures were lower at 50 m than normal except in the southernmost part of the area.

The conditions are further illustrated in Figures 15—20. Off Cape Farewell and Frederikshåb the arctic component of the West Greenland Current seems to be weak, and the temperature at its core was not so low as usual. The warm Irminger Current was well developed. West of Fylla Bank and Lille Hellefiske Bank the temperature in the upper 100 m was lower than in 1957, which probably is due to stronger winter cooling. The Irminger Current, which is found here as an undercurrent was well developed.

In the western part of the three northernmost sections the cold Baffin Land Current with temperatures below —1°C was met. The boundary of this current seems to lie further east than usual.

A fixed station at the entrance to Godthåb fjord (64°07′N, 51°53′W) was worked frequently throughout the year with the "Adolf Jensen" and the

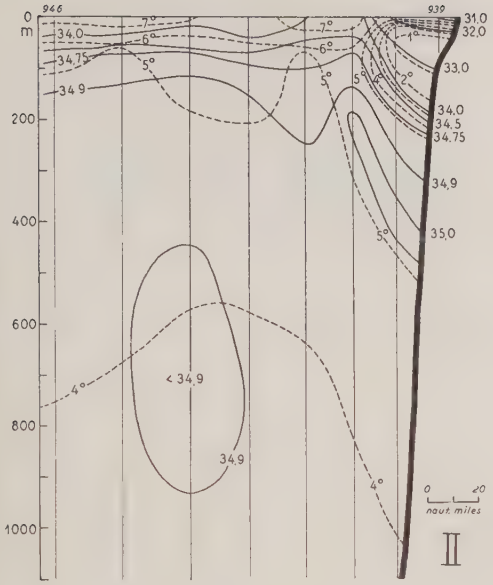


Figure 16. Section II off Frederikshåb, 9.—10. August 1958.

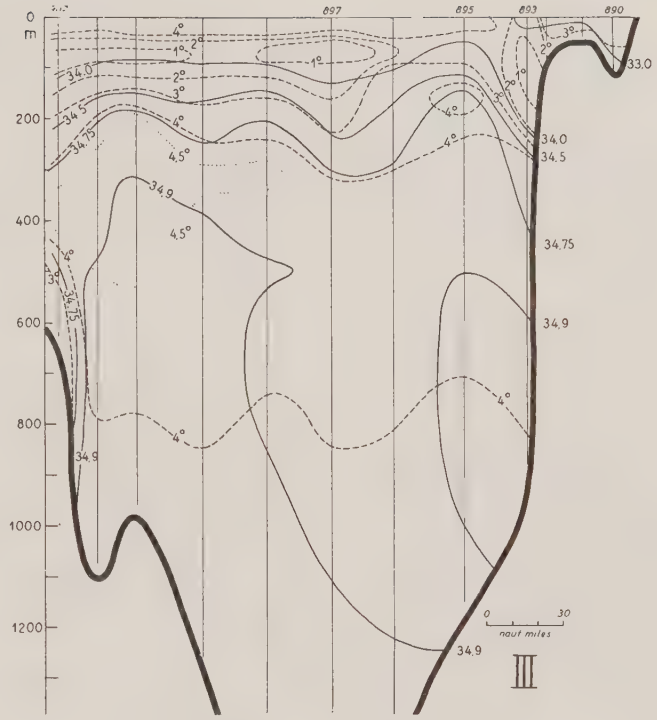


Figure 17. Section III across Fylla Bank, 17.—20. July 1958.

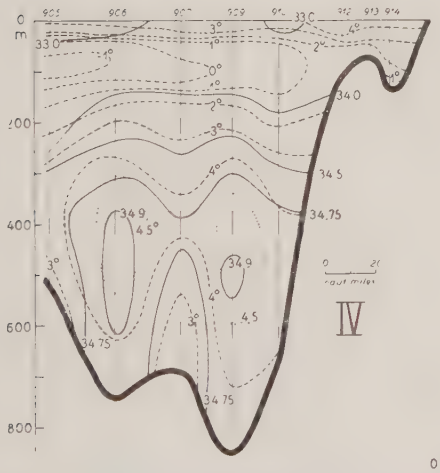


Figure 18. Section IV across Lille Hellefiske Bank, 20.—22. July 1958.

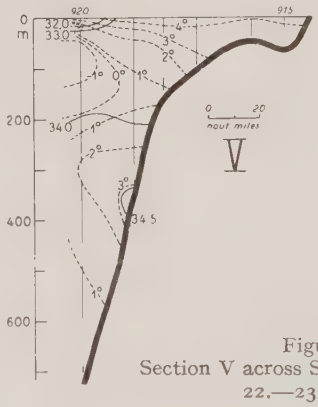


Figure 19. Section V across Store Hellefiske Bank, 22.—23. July 1958.

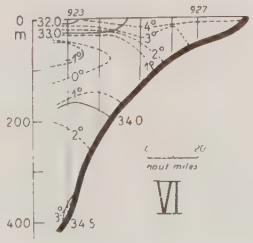


Figure 20. Section VI off Egedesminde, 24. July 1958.

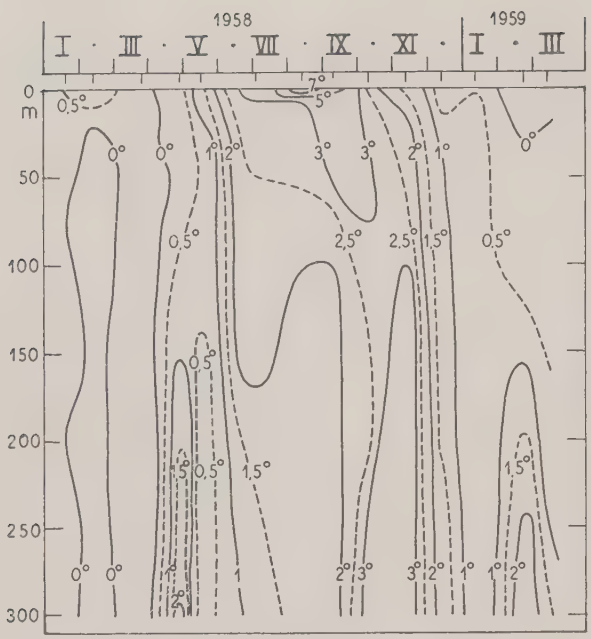


Figure 21. Variation of temperature at the entrance to Godthåb fjord.

"Tornaq". The variation of temperature from January 1958 to March 1959 is shown in Figure 21. The winter cooling in 1958 was strong, so water with negative temperature reached from surface to bottom both in January and March. In late April an inflow of warm bottom water took place and a still stronger inflow of warm bottom water occurred in October/November. The winter cooling in 1959 was less severe than in 1958.

F. Hermann

B. Near Northern Seas

Hydrographic Conditions in the North Sea in 1958

(Figures 22–30)

In 1958, the R/V "Dana" and the "Jens Vœver" made hydrographic observations in the North Sea. The "Dana" was in commission during May—June and again in November—December, whereas the "Jens Vœver" co-operated in the Bløden Ground region in July—August with research vessels from other countries in a temperature survey in connexion with the ICES herring tagging experiments.

Figures 22—26 show the bottom temperatures in the various periods. Spring and early summer temperatures were rather low in the Bløden Ground

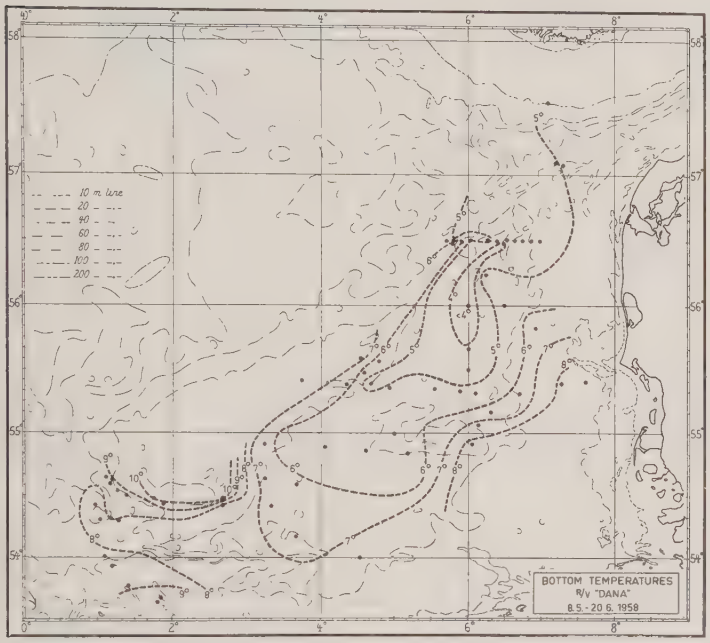


Figure 22. Bottom temperatures, 8. May to 20. June 1958.

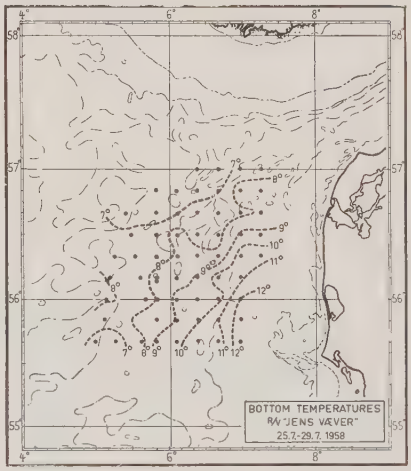


Figure 23. Bottom temperatures, 25.—29. July 1958.

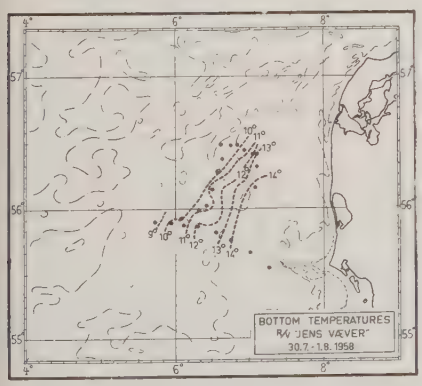


Figure 24. Bottom temperatures, 30. July to 1. August 1958.

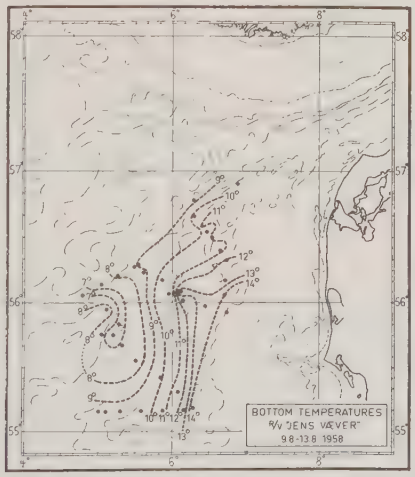


Figure 25. Bottom temperatures, 9.—13. August 1958.

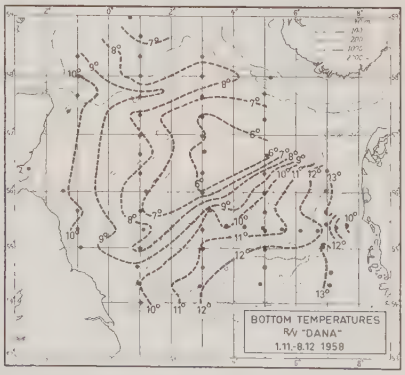


Figure 26. Bottom temperatures, 1. November to 8. December 1958.

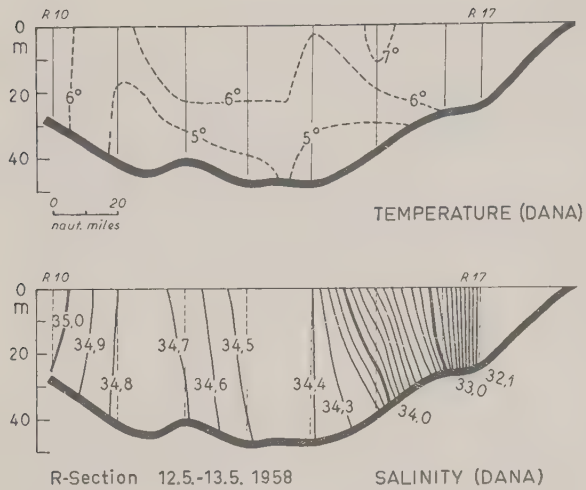


Figure 27. R-section, temperature and salinity, 12.—13. May 1958.

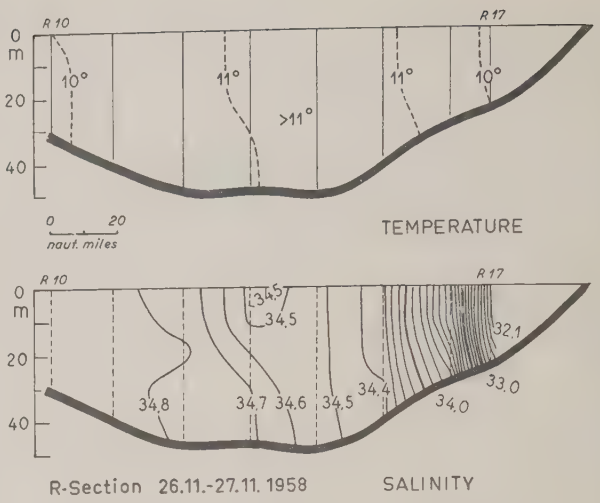


Figure 30. R-section, temperature and salinity, 26.—27. November 1958.

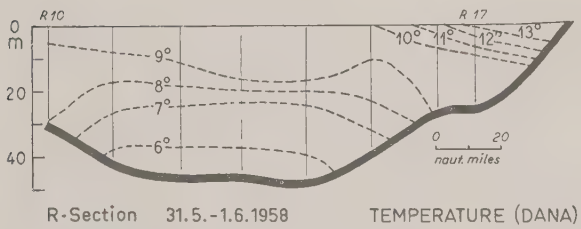


Figure 28. R-section, temperature, 31. May to 1. June 1958.

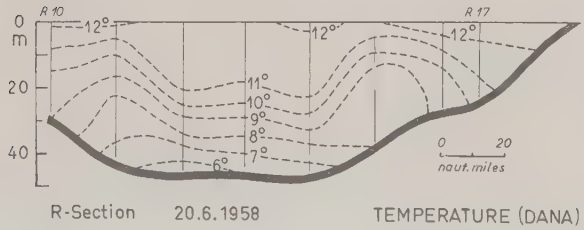


Figure 29. R-section, temperature, 20. June 1958.

region. The international R-section is shown in Figures 27—30. From inspection of these figures it will be seen that the thermocline was well developed at the end of May. A rapid change in temperature conditions in the northern part of the Bløden Ground is shown in Figures 23—26. This change was presumably brought about by a gale blowing from 28.—29. July, starting from SSE and turning clockwise to WSW.

The November—December temperatures appeared to be above normal, in contrast to the spring conditions. In this period the thermocline existed only in the region north of the Dogger Bank.

K. P. Andersen

Hydrographic Surveys of the Northern North Sea in 1958

(Figures 31–33)

Widespread cover of the northern North Sea was severely limited in 1958 due to other commitments. A series of hydrographic sections was taken extending about 100 miles E x N from the Aberdeenshire coast in the period February to July. A detailed survey of Shetland waters was carried out in July, see Figure 31. From September to December area surveys were carried out of the region from 55°N to 57°45′N and from 2°W to 1°30′E. Two of these are reproduced here, Figure 32 for late August, and Figure 33 for October.

Temperature and salinity conditions generally approximate to the long-term mean and are not in any way exceptional. The deep water of the Fladen Ground remained at a temperature of about 5.8°C until August (cf. 5.5°C in 1955 and 6.8°C in 1957). Surface temperature in the same region rose to a maximum of about 13.7° in August (cf. 13.0 in 1954 and 15.3 in 1955). The Shetland survey

Figure 31. Temperature and salinity (expressed as D.C.I.) in the Shetland region 6.—16. July 1958.

again shows average temperature and salinity conditions in the North Sea, though to the west of Shetland oceanic water is only apparent well to the north. On the whole salinity to the west of Shetland is lower than in the past few years.

Evidence from drift indicators suggests that circulation was abnormally slight. During the period April—June no southward movement was apparent in the waters off the Buchan coast. During July normal southward drift took place at a rate of about 4 miles per day. During August there may have been a reversal of the usual circulation though the evidence is unsatisfactory. Subsequent to August the circulation rate does not seem to have exceeded 2 miles per day.

R. E. Craig

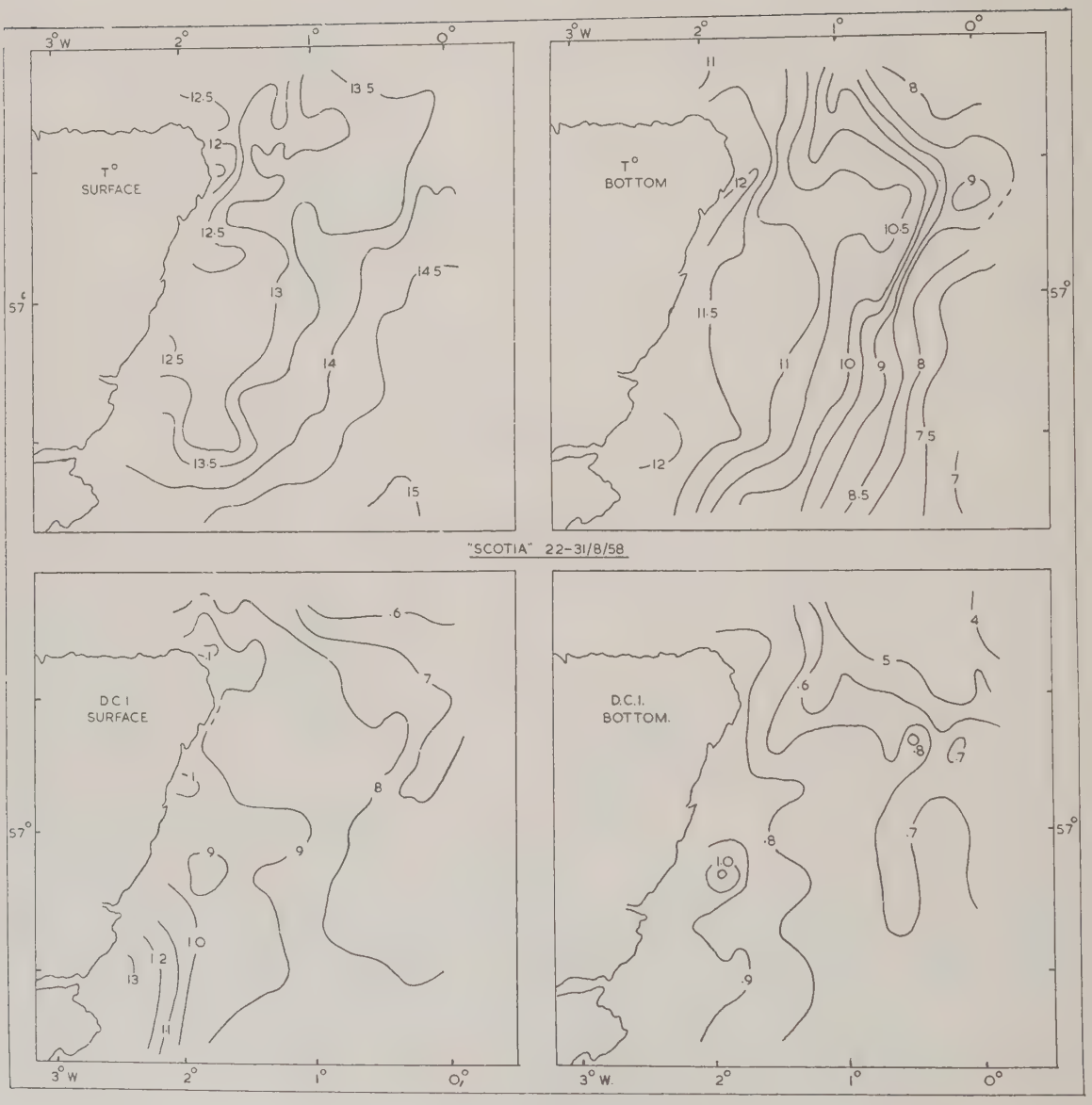
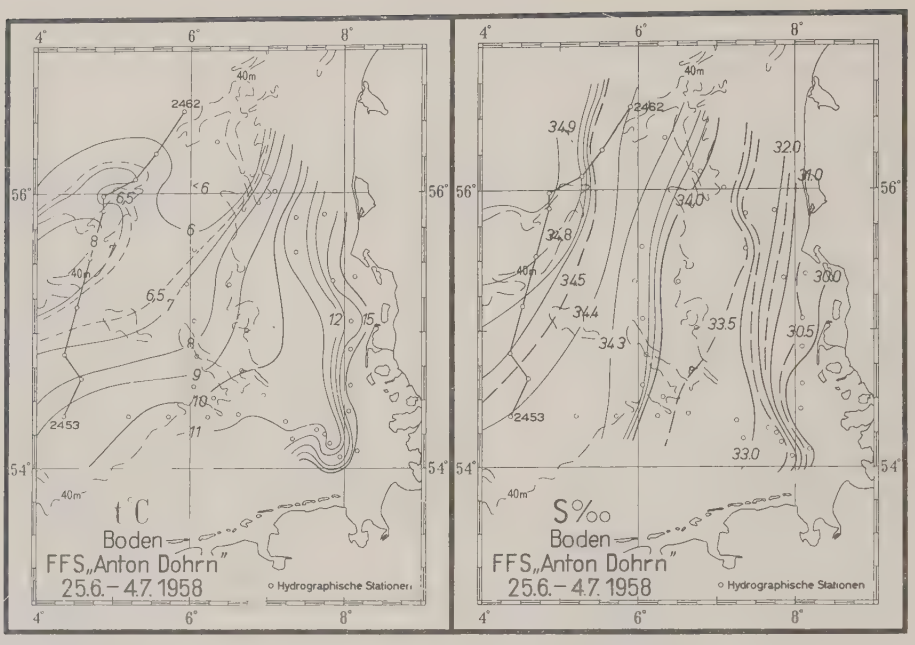


Figure 32. Temperature and salinity (expressed as D.C.I.) in the region east of Scotland 22.—31. August 1958.

Figure 33. Temperature and salinity (expressed as D.C.I.) in the region east of Scotland 14.—28. October 1958.



Figures 34 and 35. Bottom temperatures and salinities in the central and northern North Sea in the period 25. June to 4. July 1958.

Hydrographical Observations in the Central and Northern North Sea

(Figures 34–37)

Between 25. June and 4. July 1958 the fishery research vessel "Anton Dohrn" occupied several trawl stations in order to study the population of plaice. The position of the hydrographical stations, comprising 44 series of measurements, together with bathythermograph lowerings is given in Figure 34. On account of the rather open net of stations it is only possible to record the main features of the hydrographic conditions. These are presented in Figures 34—37.

Figures 34 and 35 show the distribution of temperature and salinity near the bottom. Figure 35 reveals that two bodies of water of different origin may clearly be distinguished, viz.:—

(1) North Sea water with a salinity of 34.0 to 35.0 ‰, far from the coast. It is situated between the coastal and the Atlantic water, the presence of which latter is indicated by the course of the 34.9 ‰ isohaline in the north-west of the area of investigation.

(2) East of Helgoland the coastal water has a salinity of only 30.0 ‰ and extends in the southern part of the area of investigation as far as longitude 6°E.

At 56°N and 6°E a body of cold water with temperatures of 6°C and below was located.

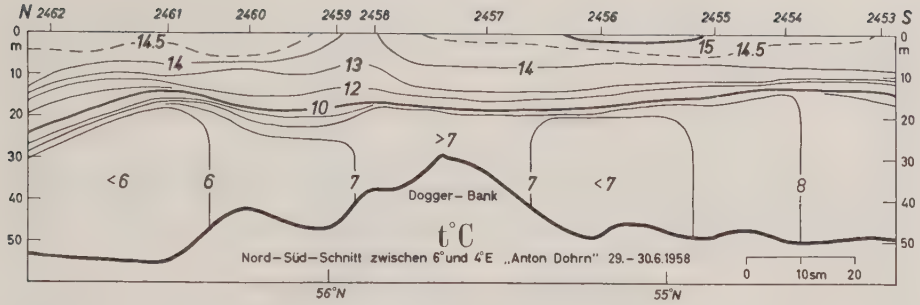
Figures 36 and 37 show the vertical distribution of the hydrographic factors and demonstrate the characteristic summer stratification encountered on 29. and 30. June. A surface layer which shows only a slight temperature stratification (from 13° to 15°C) is separated by the thermocline from the colder layer below. The thermocline, blocking the vertical turbulence, was found north of the Dogger Bank at a depth of 15 m, and is some 15 m thick there.

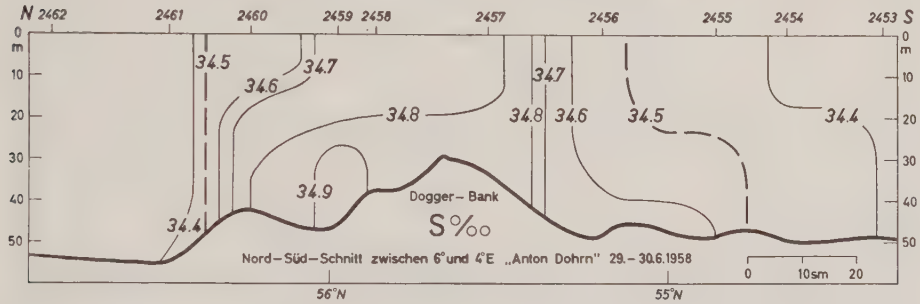
According to the effect of the turbulence of the tidal streams, the following typical regions of thermal stratification may be distinguished:—

(1) The area north of Station 2458, characterized by a temperature discontinuity layer up to 15 m thick. The lower layer shows temperatures of 6° to 7°C and is only slightly stratified. The effect of turbulence is only recognizable in a thin mixing layer near the bottom.

(2) The Dogger Bank where the water masses show no trace of stratification below the thermocline which is less than 5 m thick.

(3) The region south of the Dogger Bank into which the thin thermocline layer extends, separating a lower layer with temperatures of 7°—8°C from the surface layers.





Figures 36 and 37. Temperature and salinity in a north-south section across the Dogger Bank between 6° and 4°E, from observations made on 29.—30. June 1958.

It is as if the turbulence produced by the strong tidal currents compresses the thermocline into a narrow band in regions 2 and 3.

E. Rogalla

Hydrographic Conditions in the Dogger Bank Region in October 1958

(Figures 38–41)

Hydrographic observations were made by the fishery research ship "Anton Dohrn" from 10. to 29. October during a cruise in the central and southern North Sea. The research vessels "Sir Lancelot", "Clupea", "Willem Beukelsz", and "Anton Dohrn" co-operated in elucidating the hydrographic conditions. The entire hydrographic programme comprised 231 stations with 151 vertical temperature recordings. Observations of temperature and salinity in the Dogger Bank region were undertaken as a basis for studying the influence of the hydrographic factors on the size and distribution of fish stocks. Some results are presented in Figures 38—41.

The distribution of temperature and salinity in the bottom layers, the position of the stations, and the course of the two vertical sections are shown in Figures 38 and 39. The spread of the water masses of different origin can more easily be traced from the salinity pattern (Fig. 39) than from that of the temperature.

(1) Comparatively warm water of a high salinity flows from the English Channel northwards and penetrates into the German Bight.

(2) The English coastal water is located between the warmer Channel water and the colder Atlantic water intruding from north and north-west into the North Sea. The direction of flow is influenced by the bottom topography (Silver Pit groove).

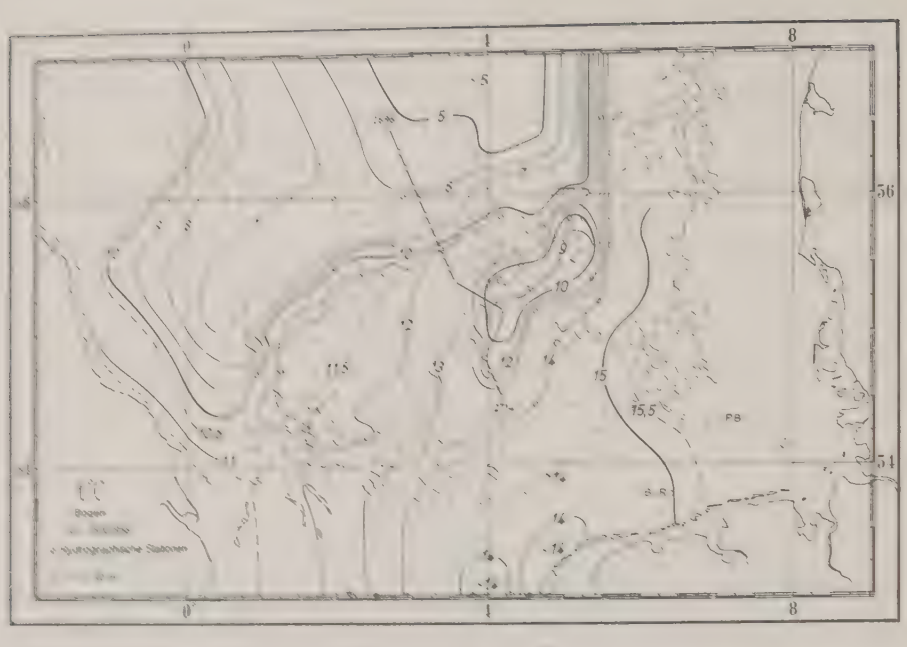
(3) In the offshore area along the Netherlands and German coasts, the water masses are influenced by admixture of fresh water from the rivers Rhine, Meuse, and Elbe.

(4) The influence of the cold Atlantic water penetrates between the English coast and the Dogger Bank as far as the latitude of Flamborough Head.

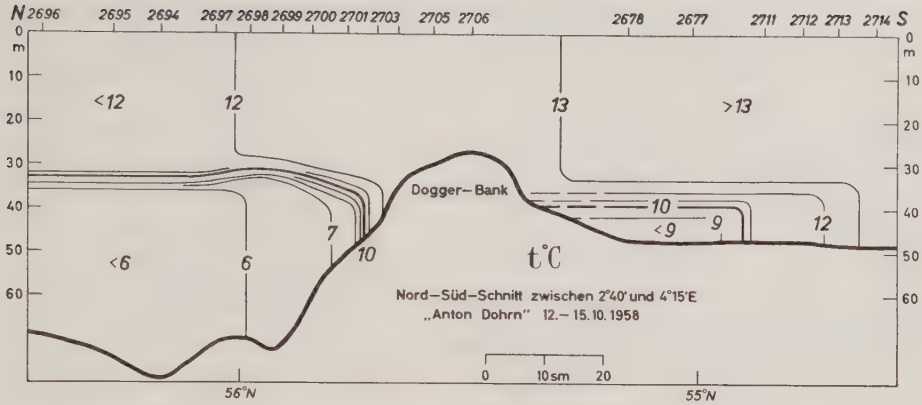
(5) South-east of the Dogger Bank (see Fig. 38) an isolated water body can be distinguished. Its core has a temperature of 9°C.

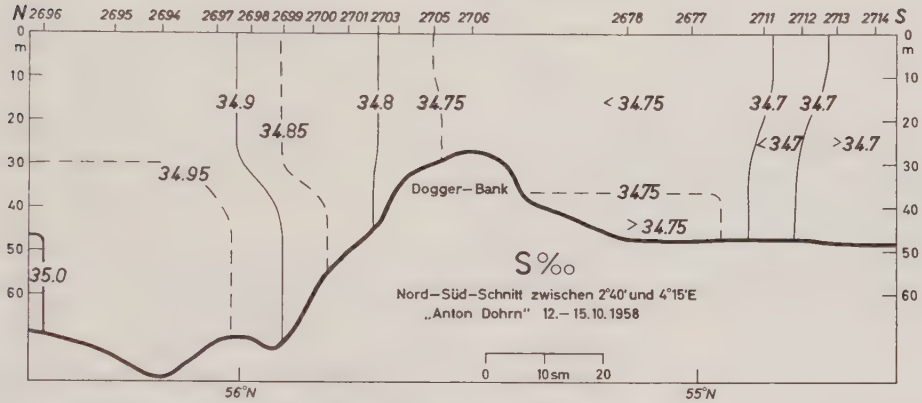
Taking into account the different depths and the various effects which the tidal streams exert, the area investigated may be subdivided into two typical regions, as clearly seen from the two north-south profiles (Figs. 40 and 41), viz.:—

1. The shallow part of the Dogger Bank and the German Bight outside the coastal region, covered



Figures 38 and 39. Bottom temperature and salinity in the Dogger Bank region in October 1958.





Figures 40 and 41. Temperature and bottom salinity in a north/south profile across the Dogger Bank between 2°40′ and 4°15′E. The observations were made in the period 10.—29. October 1958.

with homogeneous water masses. The stratification observed here in June and July 1958 during a research cruise with the "Anton Dohrn" could not sustain until October, for wind and tidal streams produce too strong turbulence in such shallow water. The layer of sharp discontinuity of density, built up in spring, and acting as an obstacle for the vertical turbulence, disappeared later.

2. Areas with stratified water, encountered north and south of the Dogger Bank. At a depth of some 32 m two cold-water bodies were separated by a marked temperature discontinuity layer from the overlying almost homothermal water masses. Compared with the preceding year the northern water body with temperatures below 6°C, is by 2° colder. Its 5° isotherm was situated a few miles north of Station 2696. The cold bottom water south-east of the Dogger Bank with temperatures below 9°C, is about 1°C colder than in the preceding year. The temperature of this water body was built up by vertical transport of heat, which started in spring but did not penetrate below the surface layer mixed by wind and waves. This water extended as far as the Upper Scruff, i. e., approximately as in September 1956. The depth of the thermocline lying over the cold winter water was determined by bathythermograph lowerings. The 10° isotherm of the south-eastern bottom water was found at a depth of 39 m. The 10° isotherm of the Atlantic bottom water to the north of the Dogger Bank was encountered at a depth of 32 m between Station 2696 and Station 2697. At Station 2698 the whole discontinuity layer bent slightly.

Both bodies of cold bottom water can also be traced from the salinity data (Fig. 41). The Atlantic water is indicated by the course of the 34.95‰ isohaline, and the bottom water south-east of the Dogger Bank by a salinity of 34.75‰.

The survey of the hydrographic conditions was interrupted by a storm from NW lasting from 15. to 17. October. Subsequent measurements revealed that the 12° isotherm which was earlier observed north of the Dogger Bank (see Fig. 40) had been displaced more than 40 miles towards the German Bight under the influence of the gale.

E. Rogalla

Monthly Anomalies of the Surface Temperature in an Area off the Eastern Coast of Scotland in 1958

(Figure 42; Table 3)

Table 3 gives for each month of 1958 the anomaly of the surface temperature in the area F (56°N—60°N, 0°—3°W; see Figure 42); the grand monthly means for 1°-squares over the period 1876—1915 were used as standards.

Table 3. Monthly anomalies (△°C) and numbers (n) of observations of the surface temperature in the area F in 1958.

Jan.		Feb.		March		April		May		June		July	
△	n	△	n	△	n	△	n	△	n	△	n	△	n
0.1	34	0.1	44	−0.2	47	−0.5	55	−0.1	46	0.5	64	0.7	44

Aug.		Sept.		Oct.		Nov.		Dec.		Average
△	n	△	n	△	n	△	n	△	n	of △-values
0.2	50	1.1	40	1.3	39	1.3	44	1.1	34	0.5

It appears from Table 3 that positive anomalies are still predominant. Averaged over the year the anomaly is 0.5°C, as compared with 0.6°C in 1957. There is, however, a marked difference between the anomalies from the first and the last part of the year. Averaged over the first 6 months of the year the anomaly is 0.0°C, whereas for the last 6 months the average is 1.0°C.

JENS SMED

Figure 42. Location of area.

Hydrographic Conditions in the German Bight in 1958

(Tables 4–5)

In 1958 daily surface observations of temperature and salinity have been made (at 8^h MET) at 5 German lightships ("Borkumriff", "P 8", "P 12", "Elbe 1", and "Weser") according to the routine commenced in 1949, except at the "Borkumriff" where observations started already in 1954. (For positions, see Ann. Biol., **14**, p. 60). The observation data will be published in full in "Meereskundliche Beobachtungen und Ergebnisse". The monthly means of surface observations, given in Table 4, compared with the means for the period 1950/54 represent the estuaries and coastal waters of the German Bight. Table 4 also shows the mean values of bottom observations carried out by the "Borkumriff" lightship from which subsurface observations at various depths were made only once a week, namely on Saturdays.

In 1958, surface temperatures were comparatively low in January and in the period March to June, about normal in July and August, and above normal in February and from September to December, inclusive, in comparison with the five-year means. The 1958 surface salinities in the German Bight ("P 8" observations excepted) were rather low in the period February to August, and again in October and November, about normal in January and December, and somewhat higher than normal in September, compared with the five-year means. At the "P 8" lightship the surface salinity was about normal throughout the year in comparison with the mean values for the period 1950/54.

Table 5 shows that the annual means of temperature are normal compared with the five-year means. The annual means of salinity are also normal at "P 8" but below the normal value at the other lightships, compared with the period 1950/54.

G. KOOPMANN

Table 4. Monthly means of salinity and temperature at surface and bottom 1950/54 and 1958 at the German lightvessels "Borkumriff", "P 8", "P 12", "Elbe 1", and "Weser"

(From Deutsches Hydrographisches Institut, Hamburg)

Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity						**Surface**							
"Borkumriff"	1958	33.06	32.26	32.26	32.20	32.46	31.84	32.04	32.28	32.73	32.90	32.76	32.94
						Bottom							
	1958	33.24	32.80	32.47	32.34	32.32	31.78	31.98	32.53	33.18	32.97	33.06	32.95
						Surface							
"P 8"	Mean 1950/54	33.82	33.77	33.40	33.59	33.04	32.98	33.36	33.18	33.04	33.65	33.91	33.76
	1958	33.50	33.89	32.94	33.91	33.24	32.88	32.68	32.88	33.31	33.56	33.85	33.85
						Surface							
"P 12"	Mean 1950/54	32.77	32.47	32.35	32.19	31.89	32.08	32.15	32.29	32.05	32.36	33.04	32.84
	1958	32.18	31.75	30.61	31.64	31.42	31.33	32.14	31.93	32.48	31.81	32.66	32.72
						Surface							
"Elbe 1"	Mean 1950/54	31.71	33.36	32.95	31.15	31.38	31.80	31.65	32.01	31.53	31.57	32.28	32.03
	1958	31.53	30.40	29.90	30.66	30.31	30.80	30.58	30.44	31.40	30.92	31.50	31.37
						Surface							
"Weser"	Mean 1950/54	31.94	32.00	32.14	32.08	32.45	32.41	32.39	32.27	31.84	32.32	32.47	32.46
	1958	31.48	31.05	31.27	32.19	31.81	32.24	31.89	31.68	31.99	31.79	32.30	32.46
Temperature						**Surface**							
"Borkumriff"	1958	4.8	4.0	2.6	3.8	8.7	12.5	16.1	17.2	17.5	14.4	10.8	7.9
						Bottom							
	1958	4.9	4.3	3.1	4.0	8.9	12.9	15.9	17.2	17.6	14.7	11.1	7.8
						Surface							
"P 8"	Mean 1950/54	5.6	3.6	3.7	5.4	9.4	13.2	15.5	16.8	16.3	13.6	10.7	7.5
	1958	5.1	4.3	2.9	3.8	6.9	11.7	15.1	16.6	17.2	15.1	12.0	9.0
						Surface							
"P 12"	Mean 1950/54	4.9	3.1	3.5	5.6	10.1	13.5	15.9	17.1	16.1	13.1	10.4	7.2
	1958	4.4	3.3	2.5	4.1	8.3	12.3	15.2	16.8	16.8	14.2	11.5	8.2
						Surface							
"Elbe 1"	Mean 1950/54	3.9	2.4	3.3	5.8	9.3	13.2	16.3	17.3	16.0	12.8	9.7	6.2
	1958	3.7	2.9	2.3	4.0	8.6	11.9	15.7	16.9	17.1	13.9	11.1	7.5
						Surface							
"Weser"	Mean 1950/54	3.9	2.5	3.1	5.9	9.2	13.0	16.0	17.2	16.9	12.8	9.6	6.3
	1958	3.3	3.0	2.6	4.1	8.7	12.3	16.1	17.0	16.7	14.1	11.2	7.6

Table 5. Annual mean of surface temperature and salinity in 1958

Lightvessel	"Borkumriff"		"P 8"		"P 12"		"Elbe 1"		"Weser"	
	t °C	S ‰	t °C	S ‰	t °C	S ‰	t °C	S ‰	t °C	S ‰
Mean 1950/54	—	—	10.1	33.46	10.0	32.37	9.7	31.95	9.7	32.23
Mean 1958	10.0	32.48	10.0	33.37	9.8	31.93	9.6	30.82	9.7	31.85

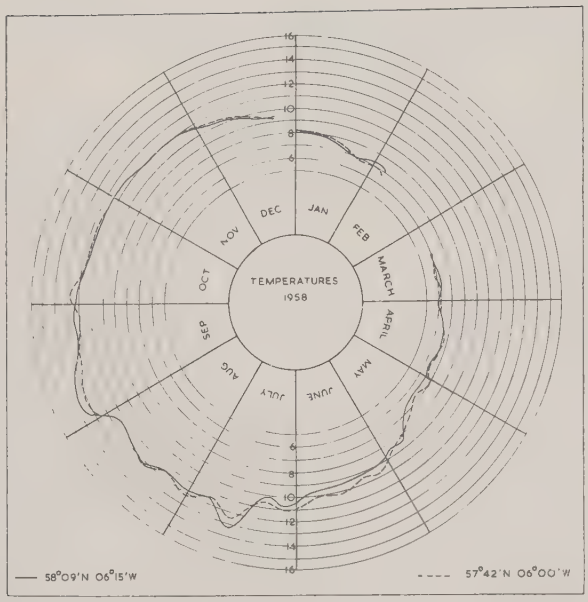


Figure 43. Sea temperature at 3 m depth at two selected positions in the North Minch. Compiled from weekly observations.

Upper Water Temperature in the North Minch in 1958

(Figure 43)

In Figure 43 is shown the variation of sea temperature at 3 m depth at two stations. These data are from a thermograph on R.M.S. "Loch Seaforth", and the Scottish Home Department is again indebted to Messrs. David MacBrayne and Captain Smith for the records.

Temperature in the early part of 1958, up to the end of June, was rather low. It then rose to a relatively high value in mid-July and fell away in August. The highest values for the year occurred in September, which seems to be unusually late, and the period from September to November seems to be distinctly warmer than in the two previous years. All three years studied show similar conditions in December.

R. E. Craig

Hydrography of the Kattegat Area Danish Waters

(Tables 6–7)

The surface salinities indicate 3 rather strong inflows of Baltic water into the Kattegat: in March/April, in June, and again in September.

The water temperatures were below normal in winter and spring, about normal in summer, and 1°—2°C above normal in the period October to December.

Helge Thomsen

Table 6. Long-period means of salinity and temperature at surface and bottom at the "Anholt Nord" lightvessel, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
Mean	23.5	23.1	20.2	19.2	18.1	18.9	19.4	20.1	20.7	20.7	21.9	22.8
Deviation 1958	−0.5	−0.7	—	−3.1	1.2	−3.0	−1.3	−0.3	−3.8	0.6	−0.4	0.3
					Bottom (30 m)							
Mean, 28 m	31.8	32.0	32.5	33.0	33.1	32.8	32.3	31.9	31.8	32.2	32.4	32.1
Deviation 1958	1.1	0.8	—	1.3	0.8	0.5	0.8	0.4	1.3	0.9	0.2	1.4
Temperature					**Surface**							
Mean	2.2	1.4	1.9	4.5	9.4	14.2	16.8	16.7	14.5	10.9	7.1	4.1
Deviation 1958	−0.2	−0.5	—	−1.8	−1.1	0.2	0.5	−0.4	1.6	1.5	1.6	1.3
					Bottom (30 m)							
Mean, 28 m	6.1	4.7	4.3	4.3	4.9	6.7	9.7	12.7	13.1	12.1	10.2	8.1
Deviation 1958	0.1	−0.2	—	0.1	−0.2	−0.7	−1.7	−0.5	−1.3	2.0	2.7	2.2

Table 7. Long-period means of salinity and temperature at surface and bottom at the "Vyl" lightvessel, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
Mean	32.6	32.4	32.2	32.4	32.3	32.6	32.5	32.4	32.6	32.4	32.4	32.9
Deviation 1958	−0.2	0.2	0.4	−0.4	−0.3	−0.4	−0.7	−0.6	−0.6	0.3	0.7	−0.5
					Bottom							
Mean	32.9	32.7	32.7	32.7	32.6	33.0	32.8	32.6	32.7	32.6	32.6	33.0
Deviation 1958	0.1	0.5	0.2	−0.5	−0.3	−0.2	−0.5	−0.1	0.0	0.5	0.7	−0.2
Temperature					**Surface**							
Mean	3.2	2.2	2.6	4.8	8.8	12.4	15.2	16.1	15.0	12.2	8.5	5.4
Deviation 1958	1.0	1.0	−0.4	−1.9	−1.7	0.1	0.0	0.2	1.9	2.1	2.5	2.4
					Bottom							
Mean	3.8	2.6	3.0	4.8	8.0	11.1	14.1	16.0	15.1	12.7	9.1	6.2
Deviation 1958	0.7	0.8	−0.8	−2.0	−1.3	−0.6	−1.0	−0.1	1.8	1.8	2.2	1.9

Swedish Waters

(Tables 8–9)

The lightvessels "Vinga" and "Svinbådan" made observations throughout the year 1958, with an interruption for "Vinga" during the greater part of March, on account of ice.

Surface salinities were below normal for the greater part of the year, very much so in June, July, and September, but above normal in February and May. Bottom salinities were predominantly below normal, especially in February and August, but above normal in April and September.

Surface temperatures were below normal during the earlier part of the year, but above the average in autumn.

Observations of the sections Pater Noster/Skagen and Skagen/Arendal were made 6 times during the

Table 8. Monthly means of salinity and temperature in 1958 at surface and bottom for the Swedish lightships "Vinga" and "Svinbådan", and deviations from the 1950—1957 means

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	IX	XII
Salinity					**Surface**							
"Vinga"	24.6	25.1	—	17.6	23.1	18.9	20.0	21.7	19.2	24.3	23.7	25.4
Deviation	0.0	1.9	—	−4.8	2.2	−1.8	−2.0	−0.4	−4.9	−0.6	−0.2	−0.4
"Svinbådan"	14.4	16.6	11.3	14.0	13.8	10.2	13.0	13.3	12.8	17.0	11.5	14.5
Deviation	−1.0	1.3	−3.6	0.7	1.4	−2.9	−1.1	0.1	−2.5	1.3	−4.1	−2.1
					Bottom							
"Vinga"	33.9	32.8	—	34.9	34.1	34.1	33.8	33.0	34.2	33.7	33.8	34.4
Deviation	0.0	−1.5	—	0.6	−0.3	0.1	0.2	−0.5	0.8	0.2	−0.2	0.6
"Svinbådan"	26.5	25.3	25.9	32.1	—	(30.3)	26.6	25.5	31.1	28.5	29.4	28.7
Deviation	−1.8	−4.1	−4.9	0.9	—	0.3	−1.5	−1.9	4.5	1.0	0.4	−0.1
Temperature					**Surface**							
"Vinga"	1.9	0.4	—	2.8	8.3	14.6	17.5	16.4	16.2	13.1	8.9	5.4
Deviation	−0.6	−0.8	—	−1.8	−1.6	0.2	0.7	−0.8	1.3	1.6	1.7	0.3
"Svinbådan"	1.9	0.9	0.1	2.8	8.5	13.2	17.2	16.3	15.7	12.3	8.4	4.9
Deviation	−0.4	−0.5	−2.0	−1.8	−1.0	−1.4	0.2	−0.8	0.8	1.1	1.8	0.2
					Bottom							
"Vinga"	5.8	4.8	—	5.0	5.1	5.9	7.4	10.7	10.2	13.8	11.4	9.1
Deviation	−0.4	−0.2	—	0.3	−0.5	−0.9	−2.0	−0.5	−3.0	1.6	1.8	1.2
"Svinbådan"	5.2	3.0	2.7	4.6	6.3	6.6	9.7	13.0	10.9	10.2	11.9	9.7
Deviation	−0.4	−1.9	−2.2	−0.4	0.6	−0.6	−0.5	0.8	−1.5	−1.6	4.8	2.5

Table 9.

M 6

58°10′N 09°30′E

	Depth, m	Date 15/1	7/2	31/3	16/5	24/11	15/12
Salinity	0	34.57	33.15	26.78	26.75	33.23	33.04
	10	34.61	33.17	30.32	32.83	33.19	33.04
	20	34.78	33.19	32.48	33.94	34.91	33.04
	30	34.85	34.74	33.22	34.37	34.97	34.58
	50	35.00	34.90	34.23	34.78	35.14	35.10
	100	35.15	34.85	34.83	35.00	35.15	35.14
	200	35.22	35.01	35.03	34.98	35.21	35.21
	400	35.15	35.15	35.11	35.12	35.21	35.23
	600	35.14	35.13	35.16	35.16	35.23	35.27
Temperature	0	6.79	4.03	1.49	7.52	8.66	7.15
	10	6.92	4.04	0.55	3.54	8.65	7.10
	20	7.45	4.04	1.75	4.07	9.99	7.13
	30	7.72	7.01	2.59	4.93	7.90	8.38
	50	7.93	7.38	4.38	6.09	6.97	8.06
	100	8.20	6.65	6.13	6.16	6.79	6.79
	200	7.58	7.05	6.26	6.04	6.53	6.30
	400	6.13	6.30	6.12	5.54	5.62	5.62
	600	5.69	5.82	5.80	5.10	5.33	5.41

year 1958. Some data from the deepest station are given in Table 9.

ARTUR SVANSSON

Chemical Observations

(Figures 44–55)

The sequence of observations of surface concentrations of dissolved oxygen and free phosphate obtained since November 1957 does not allow serial interpretation by seasons of any one area. It is important, however, that the results be made known since they reveal some trends which may be of value.

November-December 1957

Figures 44 and 45 provide the first full pictures of surface distribution of oxygen and phosphate in this series for these months. The corresponding temperature and salinity surface values are given in Figures 46 and 47 since they fall in date between the synoptic charts[1]) for November and December. South of 55°N, December temperatures were 1.25 to 2.25°C above normal (SMED, 1958)[1]). Oxygen values (Fig. 44) were lowest where winter overturn had mixed warm surface water (100—102% saturation) and depleted bottom water (82% saturation). Phosphates (Fig. 45) showed a large degree of recovery towards winter maxima in inshore and northern waters (cf. *Annales Biologiques* for the years 1952, 1953, and 1954)[2]). Only east of Dogger Bank was there a remnant of stability with perhaps some photosynthetic activity.

July 1958

Inadequate data were secured to give a general spring-summer picture but the western side of the northern North Sea was well covered in July (Figs. 48 and 49) particularly in the regions where herring were being fished. (For temperature and D.C.I., see CRAIG, Fig. 31, p. 27.) It will be apparent from the series of diagrams presented in these reports that July is perhaps the most variable month of the year in respect of the amounts and distributions of oxygen and phosphate in the north-western North Sea. Suffice it to say here that 1958 showed an unusually late or perhaps long-protracted spring-summer photosynthetic season in the Shetland-Orkney waters and was quite unlike July 1955[3]) and 1956[4]) when the waters were low in oxygen. The high oxygen saturation, 119—121% in places (Fig. 48), soon disappeared and by August/September values were similar to those of previous years.

September-December 1958

Surveys of the North Sea were made to the north of 57°N at the end of August and beginning of September (Figs. 50 and 51), and at the end of October and beginning of November (Figs. 52 and 53). A third survey, of the western part of the North Sea between 53°30′ and 58°N, was made towards the end of October (Figs. 54 and 55). The first is intermediate in time between two similarly sited surveys in 1956[4]) but resembles the end of July and beginning of August survey very closely both in oxygen and phosphate distribution, suggesting again a retarded state of biological development in 1958 compared to 1956.

The most notable feature of Figure 53 is the very large area of high phosphate concentration (above 0.5) replacing water mainly of 0.2—0.3 μg-at. PO_4/P per litre in Figure 51 and 0.1—0.4 in Figure 53 for 1956 (27. 9. 56—11. 10. 56)[4]); this indicates, by the replenishment of the surface layers, the date when and the region where winter overturn had commenced. The extension of the mixing zone farther south, similarly revealed in Figure 55, is again chiefly confined to the waters west of the prime meridian.

Oxygen distribution provides little further information. Values reach their annual minima at the moment of first overturn and thereafter progressively increase when oxygen is absorbed as the water gets colder.

[1]) Monthly Synoptic Charts, I.C.E.S. Service Hydrographique, compiled by J. SMED.

[2]) Ann. Biol., **9**: 99—103; **10**: 84—86; **11**: 41—43.

[3]) Ann. Biol., **12**: 70.

[4]) Ann. Biol., **13**: 61.

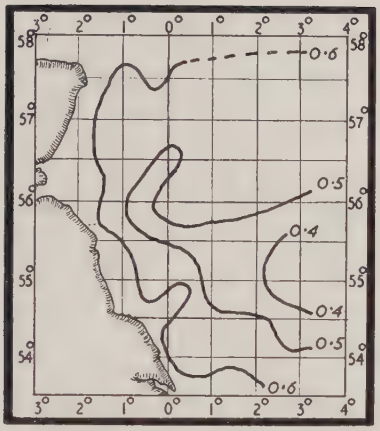


Fig. 44. Dissolved oxygen, cc. O_2/l.
23. 11. 57—5. 12. 57

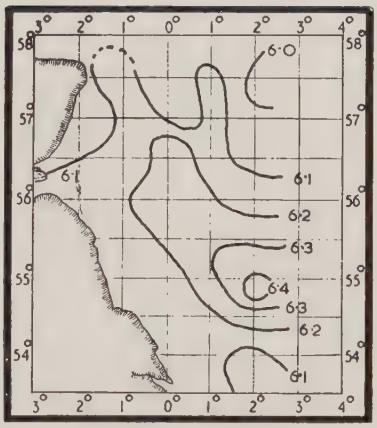


Fig. 45. Free phosphate, μg – at. PO_4 – P/l.
23. 11. 57—5. 12. 57

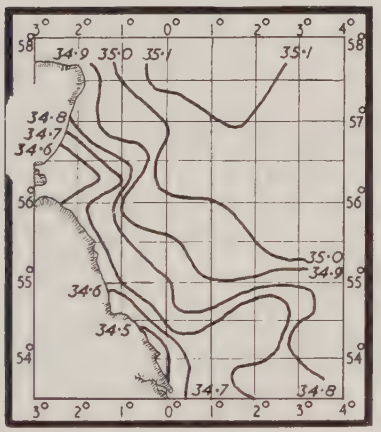


Fig. 46. Temperature, °C. 23. 11. 57—5. 12. 57

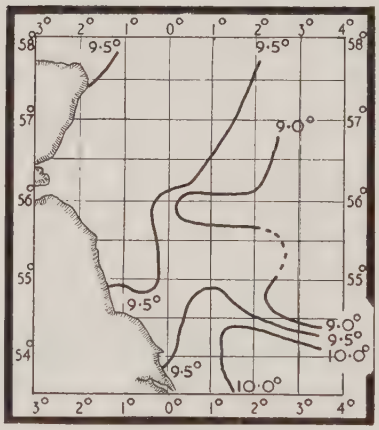


Fig. 47. Salinity, $^0/_{00}$. 23. 11. 57—5. 12. 57

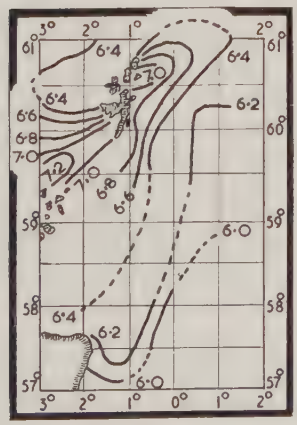


Fig. 48. Dissolved oxygen, cc. O_2/l.
4. 7. 58—16. 7. 58

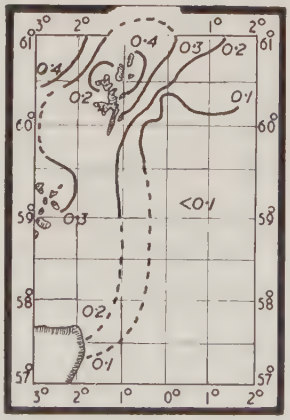


Fig. 49. Free phosphate, μg – at. PO_4 – P/l.
4. 7. 58—16. 7. 58

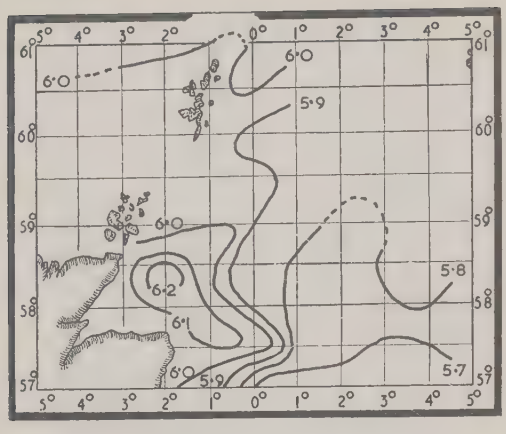


Fig. 50. Dissolved oxygen, cc. O_2/l
23. 8. 58—3. 9. 58

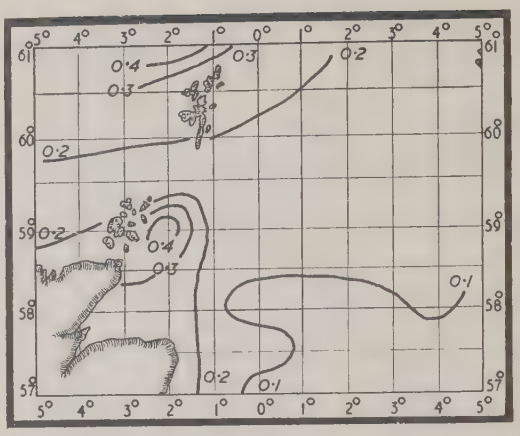


Fig. 51. Free phosphate, µg – at. PO_4 – P/l.
23. 8. 58—3. 9. 58

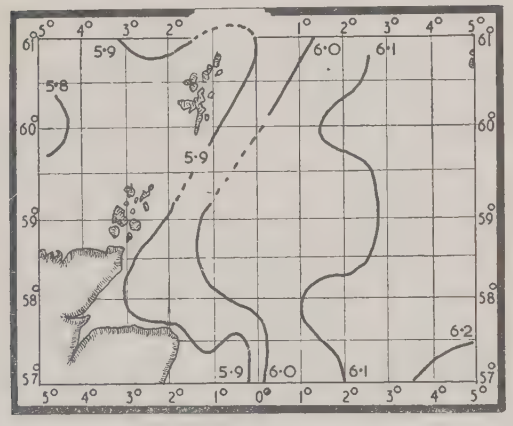


Fig. 52. Dissolved oxygen, cc. O_2/l.
26. 10. 58—14. 11. 58

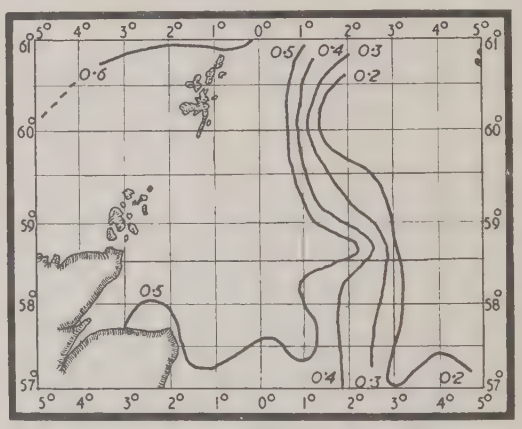


Fig. 53. Free phosphate, µg – at. PO_4 – P/l.
26. 10. 58—14. 11. 58

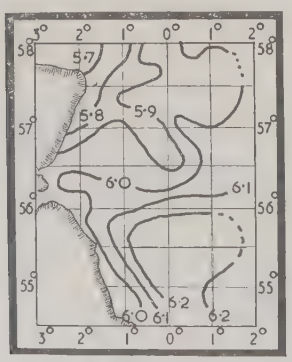


Fig. 54. Dissolved Oxygen, cc. O_2/l.
14. 10. 58—28. 10. 58

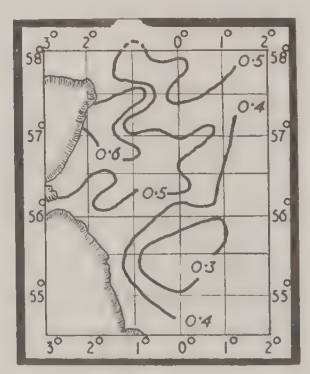


Fig. 55. Free phosphate, µg – at. PO_4 – P/l.
14. 10. 58—28. 10. 58

Allowing for the difference of three weeks in the time of sampling, there does not seem to be any major difference between Figures 54 and 55 (1958) and Figures 44 and 45 (1957). A few scattered observations for December 1958 indicated a slowing down in the spread of winter mixing, with perhaps larger unmixed regions than in 1957 and surface temperatures at least as abnormally high as in 1957.

R. Johnston, R. B. Burns

C. Baltic-Belt Seas

Danish Observations in Great Belt and the Western Baltic

(Tables 10–12)

Unusually low salinities occurred at the bottom at the lightvessels "Halsskov Rev" and "Gedser Rev" in March.

Temperatures were well above normal in October—December, but generally below normal during the rest of the year.

HELGE THOMSEN

Table 10. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Halsskov Rev" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
Mean	16.8	14.8	13.4	13.9	13.0	14.3	13.9	14.4	14.6	16.2	16.3	15.6
Deviation 1958.....	–1.4	1.4	–0.6	–1.7	—	—	—	(–1.1)[1]	–3.2	2.4	–2.2	1.0
					Bottom							
Mean	21.9	21.7	24.5	27.6	29.7	30.3	29.4	27.6	24.7	23.3	21.5	22.1
Deviation 1958	–4.3	–2.0	–8.8	–0.8	—	—	—	(0.5)[1]	3.9	4.9	5.5	2.2
Temperature					**Surface**							
Mean	2.4	2.0	2.4	4.5	8.9	12.7	15.7	16.4	14.5	11.1	7.3	4.0
Deviation 1958	–0.9	–1.1	–2.1	–1.8	—	—	—	(0.0)[1]	1.1	1.3	1.4	1.3
					Bottom							
Mean	3.9	3.4	3.4	4.3	5.7	7.1	9.1	11.7	13.2	11.6	8.4	5.9
Deviation 1958	–1.6	–1.7	–2.8	–1.2	—	—	—	(–1.1)[1]	–0.7	0.1	2.6	1.9

[1]) Data for 1.—5. August are not available. The lightvessel was withdrawn during the period 12. May to 5. August.

Table 11. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Gedser Rev" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
Mean	12.1	11.4	10.2	9.7	8.8	9.1	9.1	9.7	9.8	10.2	11.9	11.9
Deviation 1958	–1.4	–0.2	–1.5	–1.1	0.0	–1.1	0.4	–0.9	–1.2	0.9	–3.4	–0.5
					Bottom							
Mean, 15 m	13.9	12.7	13.8	13.1	12.9	13.4	12.6	11.9	12.4	12.6	12.2	13.1
Deviation 1958	–2.6	–0.8	–4.5	–2.3	–2.5	–3.1	–0.7	–1.6	1.1	2.7	1.7	1.3
Temperature					**Surface**							
Mean	2.2	1.5	2.1	4.1	8.0	12.6	15.8	16.1	14.3	11.1	7.6	4.3
Deviation 1958	0.1	–0.3	–1.5	–1.2	–0.9	–1.4	–0.9	–0.9	0.0	1.5	1.4	1.2
					Bottom							
Mean, 15 m	2.8	2.2	2.2	3.6	6.3	10.1	13.1	14.4	14.0	11.8	7.9	4.8
Deviation 1958	–0.3	–0.9	–1.6	–1.3	0.1	–0.7	0.7	0.2	–0.4	1.0	2.0	1.3

Table 12. Monthly means of salinity and temperature at Christiansø for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity												
Mean	7.0	7.0	7.0	7.0	7.0	7.2	7.4	7.2	7.0	7.0	7.1	7.0
Deviation 1958	0.9	0.7	0.6	0.6	0.7	0.5	0.6	0.9	1.1	0.6	0.4	0.6
Temperature												
Mean	3.3	2.1	1.8	3.0	6.1	11.0	15.2	16.0	14.1	11.1	8.1	5.5
Deviation 1958	0.2	−0.2	−1.2	−1.7	−1.5	−0.8	−0.7	−1.3	1.3	0.8	0.9	0.9

German Observations in the Western Baltic in 1958

(Table 13)

Daily surface observations (at 8h MET) of temperature and salinity have been carried out in 1958 from 3 German lightvessels in the manner in which it has been done since 1949. The positions are: "Fehmarnbelt" (54°36.0′N, 11°09.0′E); "Kiel" (54°29.5′N, 10°17.3′E); and "Flensburg" (54°50.3′N, 9°53.8′E). The data will be published in full in "Meereskundliche Beobachtungen und Ergebnisse". Monthly means of the observations are given in Table 13 in comparison with the means for the years 1950/54. Hydrographical subsurface observations were made daily at the "Fehmarnbelt" lightship only.

The observations made at "Kiel" and "Flensburg" lightships illustrate the conditions in the parts of the Baltic in which there are no strong currents; the observations at the "Fehmarnbelt"

Table 13. Monthly means of salinity and temperature at surface and bottom for the period 1950/54 and 1958 at the German lightvessels "Flensburg", "Kiel", and "Fehmarnbelt"

(From Deutsches Hydrographisches Institut, Hamburg)

Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Salinity							**Surface**							
"Flensburg"	Mean 1950/54	19.8	18.3	17.4	17.4	14.8	15.2	16.9	17.6	18.8	19.2	18.4	19.9	17.8
	1958	17.8	17.4	15.6	13.5	14.4	13.0	13.6	16.1	14.2	15.8	18.2	17.6	15.6
							Surface							
"Kiel"	Mean 1950/54	19.2	17.9	17.1	16.4	13.8	13.6	14.8	15.7	16.5	18.7	18.6	19.5	16.8
	1958	17.0	16.7	15.0	12.2	13.6	12.0	12.3	14.8	12.8	14.8	15.2	16.8	14.4
							Surface							
"Fehmarnbelt"	Mean 1950/54	15.4	13.5	13.5	13.0	10.3	11.7	13.2	12.1	15.4	14.8	14.5	16.4	13.6
	1958	13.4	14.1	10.7	10.8	11.3	8.9	12.0	11.4	10.4	15.2	11.2	14.9	12.0
							Bottom							
	Mean 1950/54	21.2	21.1	22.0	24.5	26.5	27.7	28.5	27.0	25.4	22.7	21.2	21.6	24.1
	1958	16.0	17.1	16.0	20.5	27.4	29.0	27.4	26.5	25.6	25.5	22.6	20.5	22.8
Temperature							**Surface**							
"Flensburg"	Mean 1950/54	2.9	1.2	1.9	4.9	10.5	14.1	15.5	16.3	14.4	11.5	7.9	5.3	8.9
	1958	2.2	1.2	0.5	2.7	7.2	13.5	16.2	16.1	16.6	13.0	8.7	5.7	8.6
							Surface							
"Kiel"	Mean 1950/54	2.7	1.1	1.9	5.1	10.0	14.3	16.5	16.7	15.0	11.7	8.4	5.1	9.0
	1958	2.1	1.1	0.4	3.0	7.7	13.2	16.1	16.3	16.0	13.1	8.4	5.4	8.6
							Surface							
"Fehmarnbelt"	Mean 1950/54	2.9	1.3	2.0	5.3	9.4	14.2	16.4	16.7	15.1	11.7	8.4	5.3	9.1
	1958	2.1	1.2	0.6	3.1	8.4	12.4	16.3	16.5	15.4	13.1	8.9	5.7	8.6
							Bottom							
	Mean 1950/54	4.2	2.4	2.8	4.0	5.3	7.0	9.0	10.5	12.6	11.9	9.7	6.2	7.1
	1958	2.4	1.7	1.2	2.5	4.7	5.9	7.0	9.6	10.3	12.4	11.0	7.2	6.3

cover regions in which both in-going and out-going currents occur.

Surface salinity in 1958 was generally lower in comparison with the means for 1950/54, except in February, May, and October but at "Fehmarnbelt" lightvessel only.

Surface temperatures were comparatively low from January to June, about normal in July/August, and somewhat higher than normal for the rest of the year 1958 compared with the five-year means.

From January to September 1958 the bottom temperatures were abnormally low and for the remainder of the year they were above normal compared with the five-year means.

The bottom salinity values were high in May, June, October, and November, about normal in

Table 14. Monthly means of salinity and temperature in 1958 at surface and bottom at Swedish lightships with deviations from the 30-year means

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity					**Surface**							
"Sydostbrotten"	—	—	—	—	—	4.5	4.6	5.2	(4.7)	4.9	5.4	5.5
Deviation	—	—	—	—	—	−0.2	0.3	0.9	0.1	0.0	0.2	0.2
"Finngrundet"	5.8	—	—	—	—	(5.7)	5.6	5.7	5.6	5.6	5.6	5.8
Deviation	0.4	—	—	—	—	0.2	0.2	0.4	0.4	0.3	0.2	0.5
"Svenska Björn"	6.7	6.6	—	—	(6.2)	6.2	6.1	5.9	6.0	(6.1)	6.4	6.7
Deviation	0.5	0.4	—	—	0.3	0.5	0.6	0.4	0.4	0.2	0.3	0.6
"Falsterborev"	9.4	8.6	8.0	7.5	7.7	7.6	8.0	7.8	7.6	7.8	8.0	8.0
Deviation	1.2	0.5	0.2	0.0	0.3	0.1	0.1	−0.1	−0.4	−0.6	−0.3	−0.3
"Oskarsgrundet"	16.7	11.1	—	11.1	8.8	8.7	10.7	9.3	9.2	9.0	8.9	13.1
Deviation	5.6	−0.2	—	1.6	0.4	−1.1	0.8	−0.3	−1.6	−2.8	−1.6	1.1
					Bottom							
"Sydostbrotten"	—	—	—	—	—	5.9	5.0	6.0	(6.0)	5.7	5.9	5.6
Deviation	—	—	—	—	—	0.3	−0.7	0.3	0.4	0.1	0.3	0.0
"Finngrundet"	5.8	—	—	—	—	(5.9)	5.9	5.8	5.8	5.7	5.7	5.8
Deviation	0.0	—	—	—	—	0.2	0.1	0.1	0.0	0.0	0.0	0.1
"Svenska Björn"	7.1	6.9	—	—	(6.5)	6.6	6.9	7.1	6.7	6.9	6.9	7.0
Deviation	0.2	0.2	—	—	−0.3	−0.8	−0.4	−0.6	−0.5	0.4	0.0	0.2
"Falsterborev"	9.5	8.8	8.0	7.5	7.8	7.6	8.3	7.9	7.6	7.9	8.1	8.0
Deviation	1.0	0.5	0.2	−0.1	0.3	0.0	0.2	−0.3	−0.6	−0.8	−0.2	−0.5
"Oskarsgrundet"	17.5	14.0	—	16.2	12.3	12.1	10.8	9.7	12.4	18.5	12.0	14.2
Deviation	3.9	0.2	—	3.8	2.5	−0.1	−0.7	−1.1	−0.3	4.5	−2.1	−0.3
Temperature					**Surface**							
"Sydostbrotten"	—	—	—	—	—	7.8	11.4	13.0	12.6	8.1	4.7	1.8
Deviation	—	—	—	—	—	−0.6	−2.7	−2.4	0.7	0.4	−0.1	−1.4
"Finngrundet"	(0.7)	—	—	—	—	6.6	12.8	13.6	13.4	(9.3)	6.2	3.7
Deviation	−0.9	—	—	—	—	−0.7	−1.0	−2.0	1.3	1.3	1.1	0.7
"Svenska Björn"	2.0	(0.7)	—	—	(2.6)	7.4	13.6	13.4	14.0	10.4	7.5	4.4
Deviation	−0.4	−0.5	—	—	−1.6	−1.5	−1.1	−2.4	0.9	1.4	0.9	0.1
"Falsterborev"	2.2	1.3	0.2	1.5	5.9	11.6	15.8	14.8	15.4	13.0	9.3	5.1
Deviation	−0.7	−0.5	−1.8	−2.2	−1.9	−0.8	0.0	−1.7	0.7	1.3	0.9	0.0
"Oskarsgrundet"	2.3	1.3	0.2	2.4	7.4	11.8	16.4	15.4	15.4	12.4	9.0	5.3
Deviation	−0.5	−0.6	−2.0	−1.9	−1.0	−1.3	0.3	−1.3	0.6	1.0	1.0	0.6
					Bottom							
"Sydostbrotten"	—	—	—	—	—	1.1	1.4	1.6	—	2.5	3.8	2.7
Deviation	—	—	—	—	—	−0.9	−0.9	−1.0	—	−3.7	−1.6	−1.4
"Finngrundet"	(0.8)	—	—	—	—	3.0	3.3	5.2	5.0	(7.0)	6.1	4.0
Deviation	0.8	—	—	—	—	−1.5	−1.9	−0.1	−0.8	0.5	1.0	1.1
"Svenska Björn"	2.8	(1.4)	—	—	(1.5)	3.0	4.0	3.9	4.7	6.9	7.4	4.5
Deviation	0.1	−0.2	—	—	−0.9	−0.2	0.2	−1.4	−0.9	0.6	1.3	−0.1
"Falsterborev"	2.2	1.4	0.2	1.5	5.8	10.1	15.4	14.4	15.2	13.0	9.4	5.0
Deviation	−0.7	−0.4	−1.8	−2.1	−1.7	−1.7	0.8	−1.3	0.6	1.3	1.0	−0.1
"Oskarsgrundet"	2.5	1.5	0.2	2.5	7.3	11.6	16.1	15.5	15.1	11.8	9.3	5.8
Deviation	−0.9	−0.9	−2.3	−1.8	−0.8	−0.9	0.3	−1.0	0.4	0.3	0.9	0.5

August, September, but throughout the rest of the year 1958 below normal in comparison with the means for 1950/54.

According to the five-year means the annual means of temperature and salinity are below normal (see Table 13).

G. Koopmann

Observations at Swedish Lightvessels

(Tables 14–15)

The monthly means of temperature in 1958 at the lightvessels in the Baltic show the values for January to August were below normal, while those for the remainder of the year were above normal.

The stagnation of the water of the deep basins of the Baltic has continued during 1958 with lower salinity and oxygen values and higher concentration of phosphate (see Table 15). In the Gothland Deep no oxygen has been found since the beginning of 1957.

Artur Svansson

Table 15. Hydrographic data from the deep basins of the Baltic

Bornholm Deep

55°15′N, 15°59′E

14. February

Depth, m	Temp. °C	S ‰	O_2 ml/l	Alk. m val./l	PO_4–P µg–at./l	pH
0	2.53	7.87	9.04	1.49	0.24	7.98
20	2.46	7.94	8.98	1.49	—	7.87
30	2.41	7.87	—	—	0.21	8.02
50	2.50	7.87	9.03	1.48	—	8.02
60	6.04	10.92	—	—	0.63	7.80
70	5.66	13.21	2.92	1.72	—	7.43
85	5.56	14.29	1.82	1.79	1.19	7.26

27. July

0	13.72	7.53	7.37	1.48	0.15	8.09
20	12.50	7.54	7.31	1.49	0.12	8.08
30	7.07	7.57	—	—	0.14	7.95
50	1.46	7.90	8.59	1.54	0.19	7.68
60	2.15	8.95	7.13	—	0.29	7.49
70	4.75	12.61	1.47	1.80	0.67	7.04
80	5.44	14.41	0.13	1.90	1.55	7.05

21. October

0	11.83	7.53	7.14	—	0.13	8.01
30	11.88	7.55	7.14	—	0.05	8.00
40	4.24	7.69	—	—	0.06	7.63
50	3.36	7.96	7.49	—	0.10	7.55
60	5.07	9.49	5.96	—	0.27	7.45
70	4.12	11.95	2.22	—	0.44	7.12
80	5.10	13.52	0.21	—	1.21	6.90
87	5.36	14.29	0.05	—	4.4	7.02

Gothland Deep

57°21′N, 19°57′E

15. February

Depth, m	Temp. °C	S ‰	O_2 ml/l	Alk. m val./l	PO_4–P µg–at./l	pH
0	2.53	7.66	8.96	1.48	0.13	8.05
20	2.48	7.66	8.93	1.48	—	8.07
50	2.53	7.66	8.95	1.49	—	8.15
60	2.54	7.65	—	—	0.11	8.12
70	4.07	9.88	2.22	1.62	—	7.90
80	4.12	10.17	—	—	0.85	7.45
100	4.47	10.81	0.96	1.66	—	7.34
125	4.80	11.43	—	—	1.06	7.27
225	5.73	13.06	<0.2	1.82	6.0	7.53

25. July

0	13.55	7.53	—	1.50	0.21	8.19
20	11.95	7.46	7.29	1.50	0.12	8.19
30	8.25	7.64	—	—	0.16	8.05
50	3.39	7.71	8.64	1.53	0.12	7.88
60	2.26	7.90	7.79	—	0.20	7.65
70	2.50	8.49	6.16	1.54	0.27	7.43
80	3.28	9.12	—	—	0.35	7.14
90	4.04	10.12	—	—	—	7.06
100	4.42	10.45	1.15	1.63	0.92	7.02
125	4.56	10.92	—	—	—	7.00
150	5.20	12.06	—	—	—	6.99
222	5.66	13.08	0.0	1.83	8.2	7.11

8. November

0	9.32	7.46	7.61	1.50	0.04	7.91
20	9.33	7.40	7.61	1.50	<0.01	7.97
30	9.24	7.48	—	—	—	7.97
40	3.43	7.72	—	—	—	7.67
50	2.49	7.82	7.71	1.50	0.17	7.70
60	2.80	8.31	—	—	—	7.46
70	3.09	8.89	4.60	1.57	0.43	7.30
90	3.99	9.61	—	—	—	6.90
100	4.31	10.30	1.02	1.59	0.88	6.76
125	4.69	11.11	0.43	—	1.17	6.89
150	5.24	12.22	0.0	—	3.0	6.97
175	5.55	12.76	0.0	—	5.2	7.26
200	5.68	13.00	0.0	—	7.0	7.06
220	5.66	13.08	0.0	1.84	8.4	7.07

Landsort Deep

58°35′N, 18°14′E

16. February

Depth, m	Temp. °C	S ‰	O_2 ml/l	Alk. m val./l	PO_4–P µg–at./l	pH
0	0.80	6.91	9.47	1.40	0.17	7.65
20	0.98	6.94	9.39	1.42	—	7.86
30	1.41	7.17		—	0.19	7.92
50	2.83	7.46	8.43	—	—	8.03
60	2.93	7.50	—	—	0.23	7.93
70	4.12	8.65	5.10	1.55	—	7.62
80	4.07	9.40		—	0.89	7.35
100	4.29	9.98	1.77	1.65	—	7.23
200	4.53	10.57	0.92	—	—	7.17
300	4.66	10.84	—	—	1.38	7.14
425	4.73	10.86	0.58	1.70	1.38	7.16

Table 15 (continued)

Landsort Deep
58°35′N, 18°14′E

19. July

Depth, m	Temp. °C	S ‰	O_2 ml/l	Alk. m val./l	PO_4P µg-at./l
0	13.91	6.50	7.10	1.37	0.09
20	9.60	6.51	7.91	—	0.12
30	5.57	6.83	—	—	—
50	1.65	7.44	8.80	1.47	0.16
60	1.28	7.54	—	—	—
70	1.59	7.83	7.46	—	0.27
80	3.71	9.42	—	—	—
100	4.20	10.00	1.40	1.63	1.39
200	4.55	10.70	0.79	1.65	1.67
300	4.64	10.78	—	—	—
425	4.60	10.80	0.62	1.67	1.72

28. October

0	9.40	6.73	—	—	0.09
20	9.05	6.79	7.65	—	0.09
30	9.03	6.79	—	—	—
40	2.85	7.36	—	—	—
50	2.46	7.57	8.02	—	0.25
60	2.68	7.85	—	—	—
70	2.81	8.48	5.09	—	0.64
80	4.10	9.96	—	—	—
100	4.32	10.26	0.83	—	1.48
200	4.44	10.57	0.62	—	1.54
300	4.62	10.76	—	—	1.56
400	4.63	10.79	0.43	—	1.59
435	4.59	10.79	—	—	1.61

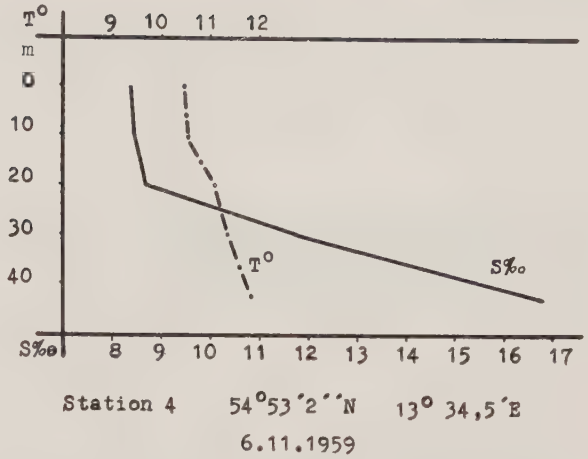


Figure 56. Arkona Deep. Variation of temperature and salinity.

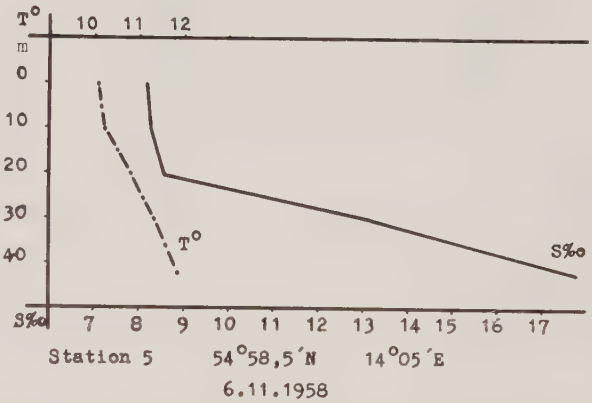


Figure 57. Arkona Deep. Variation of temperature and salinity.

Polish Observations in the Southern Baltic March 1958/February 1959

(Figures 56–59; Table 16)

In the reported period the diminution of salinity of the bottom water in the southern Baltic was continuing. The salinity at Station B_1 situated in the central part of the Bornholm Basin dropped beneath the lowest value ever reported since 1902.

The data characterizing the changes of the salinity at the bottom of the Bornholm Deep for the last 50 years show a salinity below 15‰ only twice, viz., in 1930 (14.9‰, "Dana", 19. September (*Bulletin Hydrographique* 1930, p. 83, col. 4)) and in 1946 (14.96‰, "Eystrasalt", 21. October (*Bulletin Hydrographique* 1940—1946, p. 103, col. 4)), and GLOWINSKA (1). Thus the salinity values since March 1958 seem to constitute the absolute minimum of the salinity for the period 1902—1958 (see Table 16).

According to the above statement the diminution of salinity was also progressing in the Deep of Gdańsk. The salinity of the bottom water there persisted between 10 and 11‰ until February 1959, when

Table 16.

Station	Level	March 1958 T °C	March 1958 S ‰	June 1958 T °C	June 1958 S ‰	October 1958 T °C	October 1958 S ‰	November 1958 T °C	November 1958 S ‰	January 1959 T °C	January 1959 S ‰
B_1 ..... Bornholm Deep 55°19′N, 15°45′E	Surface	0.4	7.57	6.38	7.27	13.55	7.12	8.6	7.12	3.90	7.45
	Bottom	5.3	14.78	5.55	14.51	5.58	14.31	5.52	14.16	7.00	14.42

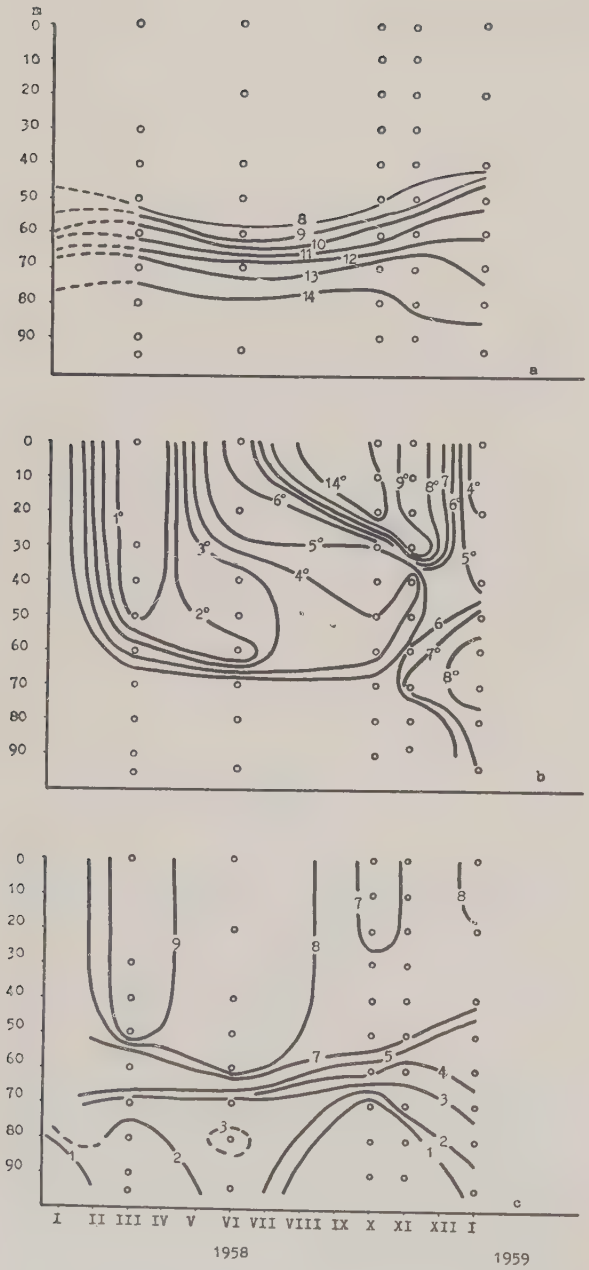


Figure 58. Bornholm Deep. Station B_1, 55°19′N, 15°45′E. Variation of (a) salinity, (b) temperature, and (c) oxygen content in 1958.

an increase in temperature and salinity (up to 11.09‰) was noted, whereas still in January the salinity amounted to 10.39‰ only.

This increase in salinity and temperature was due to an inflow of waters from the western areas of the Baltic. The presence of these waters in the

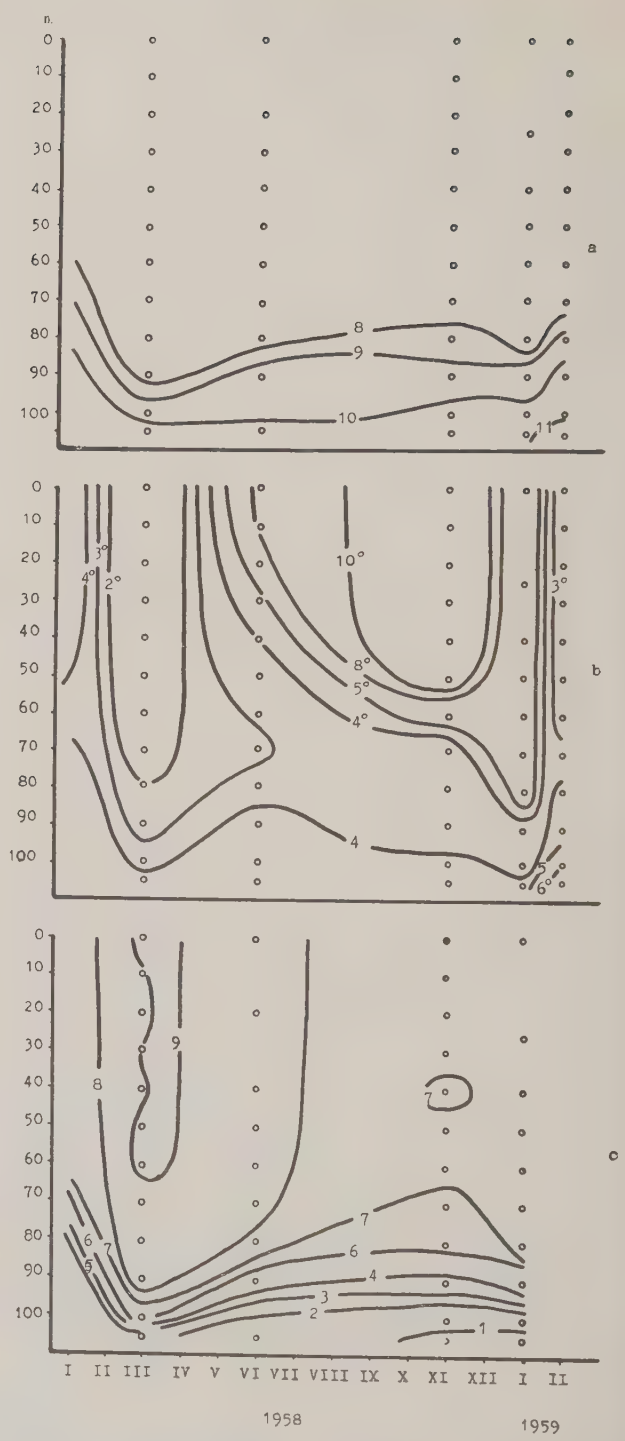


Figure 59. Deep of Gdańsk. Station G_2, 54°50′N, 19°20′E. Variation of (a) salinity, (b) temperature, and (c) oxygen content in 1958.

area of Arkona Deep at the beginning of November was indicated by a high temperature, together with an increased salinity at the bottom (Figs. 56 and 57). Simultaneously the temperature rose in the intermediary water layers of the Bornholm Deep, but here no rise in the salinity was observed. Evidently these changes intensified in January 1959, for an increase of the temperature as well as of the content of oxygen then took place right down to the bottom, whereas there was no perceptible rise in salinity. In January and February this water body was displaced along the Slupsk Furrow into the Deep of Gdańsk.

These variations in temperature, salinity, and oxygen content are illustrated in Figures 58 and 59.

J. Filarski

Reference

(1) A. Glowinska. "The temperature and salinity conditions in the southern Baltic in the first half of the 20th century." (MS, Gdynia.)

D. L'Atlantique

Conditions Hydrologiques du Golfe de Gascogne aux Côtes Ibériques en Mars 1958

(Figure 60)

Au cours d'une sortie à bord d'un chalutier de La Rochelle du 1er au 17 mars 1958, des observations hydrologiques ont été faites en surface et sont résumées sur les cartes jointes (Fig. 60).

Entre les îles Berlingues et le cap Mondego se trouvent des eaux à forte salinité (36 à 35,8‰) et de température supérieure à 13,5°C. Entre Porto et le cap Villano, le plateau continental est recouvert d'eaux de salinité comprise entre 35,3 et 35,7‰ et d'une température moyenne de 12,5°C avec, plus au large, des eaux à 13°. Du cap Villano au large du cap Peñas s'observent des eaux plus froides, entre 12° et 12,5° et de salinités assez uniformes: 35,6 à 35,7‰. De Peñas à La Rochelle, les eaux passent progressivement de 12° à 9,4° et les salinités de 35,7 à 34‰.

Il est à noter qu'au large de la côte O et NO d'Espagne, ces salinités hivernales ont des valeurs voisines de celles trouvées en juin 1952(1) et 1953(2).

J. Moreau

Reférences

(1) Le Dantec, J., & Letaconnoux, R., 1952. "Les conditions de milieu sur les pêcheries de germon en juin 1952." Ann. biol., **9**: 82.

(2) Letaconnoux, R., 1953. "Conditions hydrologiques en juin sur les pêcheries de germon". Ibid., **10**: 61.

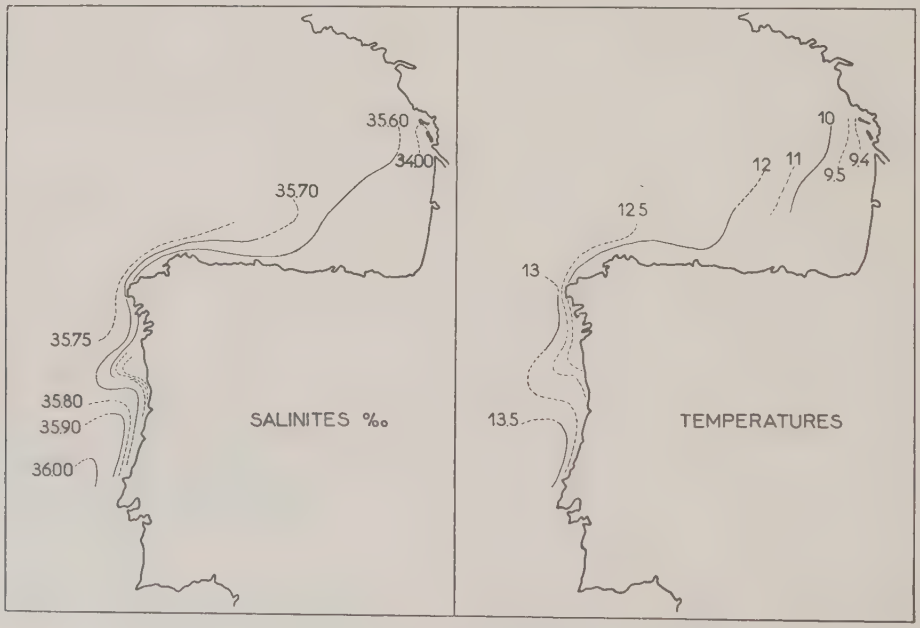


Figure 60. Salinités et températures en surface du premier au 17. mars 1958

PART II.

PLANKTON AND BENTHOS

A. Distant Northern Seas

Measurements of Primary Production in Icelandic Waters

(Figures 1–4)

During the hydro-biological survey of "Ægir" in Icelandic waters in May—June 1958 measurements of primary production were carried out using the ^{14}C technique. Samples were taken at standard depths, 0, 10, and 20 m, illuminated at about 7,000 lux on a rotating disc in a tank. The temperature in the tank could be regulated and was kept similar to that of the sea where the samples were taken.

The data are presented as 10^{-4}mg C/litre/hour, in three horizontal charts for 0, 10, and 20 m (Figs. 1—3). Density curves for some sections are shown in Figure 4.

As known from previous investigations the area in question is very heterogeneous as to water masses and mixing activities. This heterogeneity offers varying conditions for phytoplankton growth in the different localities in the area, and we may expect differences in magnitude of primary production from one place to another. From a single survey such as the one described here it is very difficult, if not impossible, to compare directly the productivity values for the different regions. In some of the localities the productivity may have been measured at the peak of the phytoplankton growth, in other localities the growth may have been almost finished, or has not yet begun. So far, very little is known regarding the annual cycle of the plant production in the different regions. However, some main features are pointed out below.

1. On Selvogsbanki where the route started on 19. May, the high rates of production and the relatively low stability suggest that the productivity was measured about the time of a spring maximum. A few samples from the stations on the shelf have been counted using UTERMÖHL's technique. They show an ample growth of diatoms, *Chaetoceros* spp. and *Thalassiosira* spp. The area beyond the shelf is rather unproductive at this season. In agreement with this the values for the oxygen saturation there are lower than those on the bank, and the water is very unstable.

Figure 1. Production rate (10^{-4} mg C/litre/hour) at surface in the period 19. May to 13. June, 1958.

Figure 2. Production rate (10 4 mg C/litre/hour) at 10 m depth in the period 19. May to 13. June, 1958.

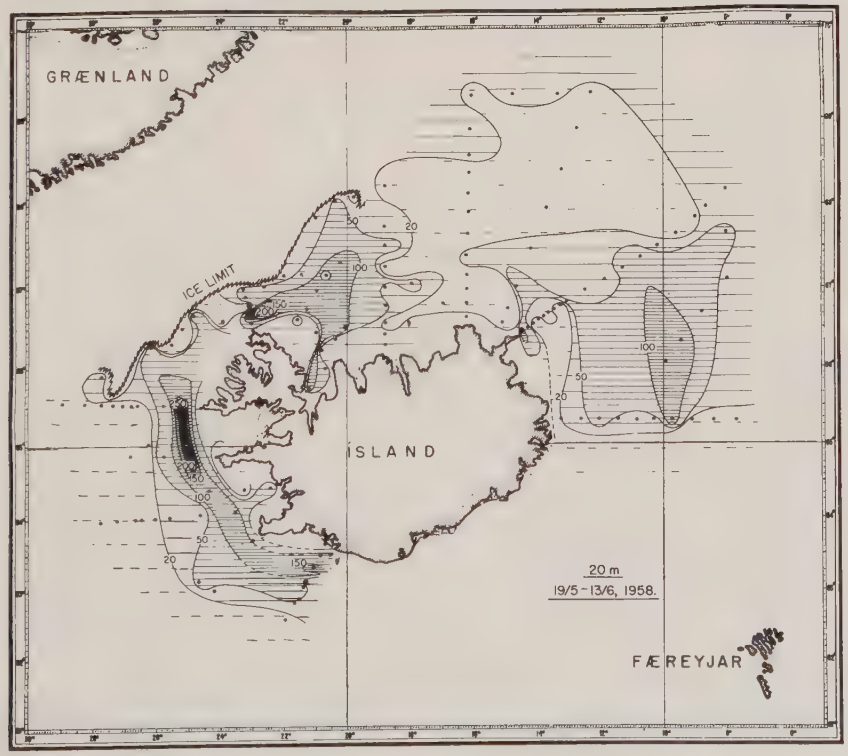


Figure 3. Production rate (10-4 mg C/litre/hour) at 20 m depth in the period 19. May to 13. June, 1958.

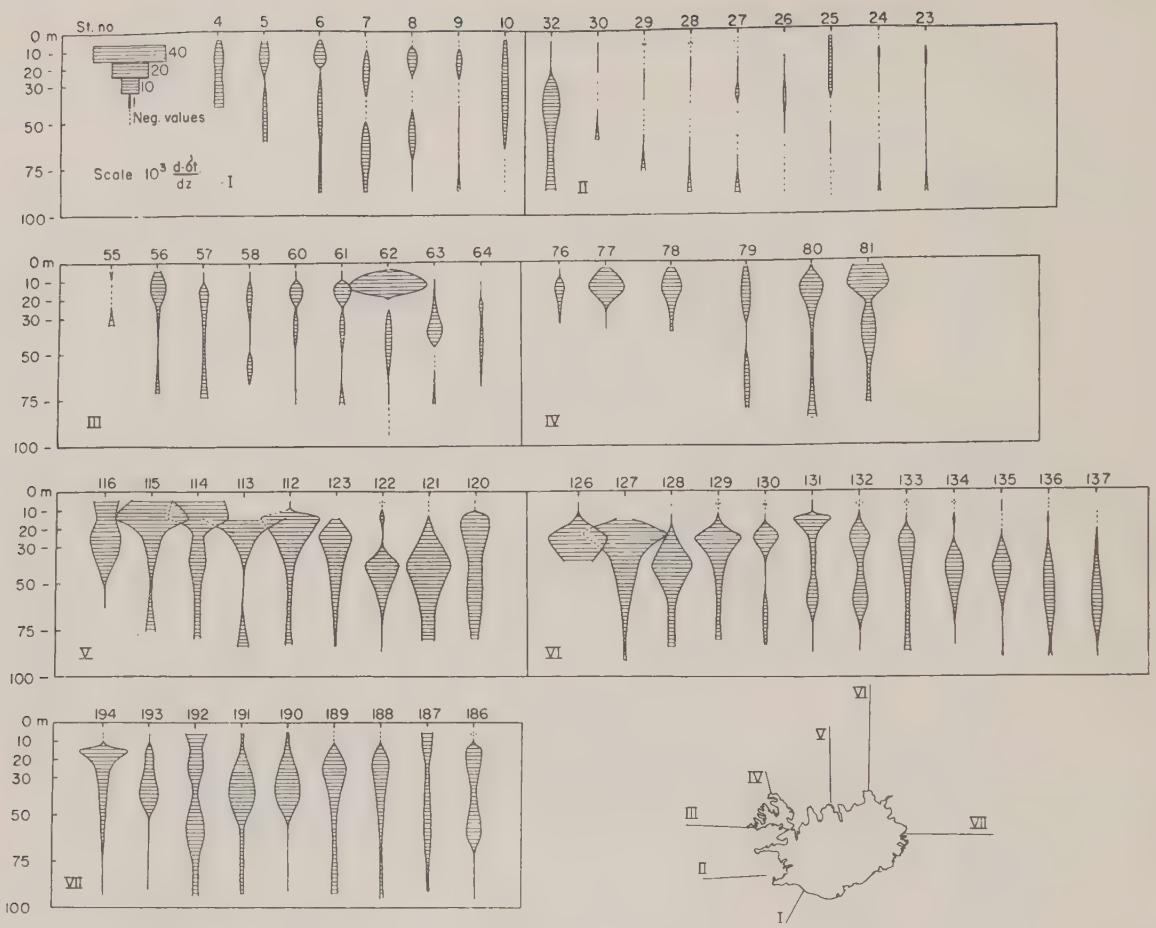


Figure 4. Density curves for seven sections in the period 19. May to 13. June, 1958.

2. West of Iceland the rate of production increases to a maximum at the edge of the shelf, then it falls off to small values in the oceanic area west of the shelf. The spring maximum was probably already over in Faxa Bay, but in the Irminger Sea the stability conditions indicated that the water was too turbulent for any real growth. Here the oxygen saturation values were also very low. At St. 56, west of Látrabjarg, the highest values were found for the whole area investigated (10^{-4} x 500 mg C/litre/hour in 10 m). This station is located in shallow waters near a region of strong tidal currents where the turbulence is very pronounced.

3. In the western part of the region north of Iceland high rates of production prevailed in a relatively extensive area. The maximum values were found in the Kögur section. The water masses here were fairly stable, and the high values of oxygen saturation indicate that the production had been going on for some time. It might have been the maximum spring outburst that was measured, but it is also possible that the hydrographic conditions in this locality produce a long-lasting growth of phytoplankton.

4. On the shelf north-east and east of Iceland the spring maximum seemed to be over. The production rate was low, the water masses were stable, and the values for oxygen saturation were considerable. This seems to be true for the very stabilized water masses at the shelf north of Siglufjörður, where the oxygen saturation was >130% at 20 m, but the production rate moderate to low. A fortnight later ^{14}C measurements were carried out again at these stations, and the values were still lower.

5. The oceanic area between Jan Mayen and Iceland was very unproductive during the first half of June. The lowest values in the area investigated were found in this region.

6. In the mixing area beyond the shelf east of Iceland high rates of production were found.

Thórunn Thórðardóttir

Icelandic Zooplankton Investigations

(Figures 5–8)

Since 1948 zooplankton sampling has been carried out in Icelandic waters mostly in connexion with herring surveys in spring or summer. The main object was to register the zooplankton density and to study the development of the main components of the zooplankton populations and the plankton-herring relationship.

Previously EINARSSON[1]), EINARSSON and JÓNSSON[2]), JAKOBSSON[3]), and HALLGRÍMSSON[4]) have reported on these investigations.

The density of zooplankton in the uppermost 50 m in the spring of 1951, 1956, 1957, and 1958 is illustrated in Figures 5—8. All the samples were taken with the Hensen net, silk No. 3. A remarkable feature which appears in the years 1951, 1956, and 1957 is a tongue of high zooplankton density penetrating from the Irminger Sea to the SW coast of Iceland. The dominant species in this tongue was *Calanus finmarchicus* in stages I—IV. These stages of *C. finmarchicus* also predominated in the waters between the NW coast and the ice edge. On the other hand, the older stages and mature females of *C. finmarchicus* predominated in the waters off the north coast, with the exception of the northernmost and north-easternmost parts of the area where *C. hyperboreus* was the dominant species.

In contrast to previous years[1]) poor concentrations of zooplankton were observed in the area north of the Reykjanes Ridge in the spring of 1958 (Fig. 8). In other parts of the area investigated the zooplankton density was also rather slight.

As indicated in the figures, the highest density of zooplankton occurred in spring in oceanic waters outside the banks. In accordance with the current system, it is assumed that a great part of the zooplankton penetrating from the Irminger Sea towards the banks off the SW coast of Iceland returns to the Irminger Sea by the western branch of the Irminger Current. The volume of zooplankton present on the herring grounds off the north coast is

[1]) Náttúrufræðingurinn, **4**, 1951; Fjölrit Fiskideildar, **7**, 1956.

[2]) Fjölrit Fiskideildar, **1**, 1952.

[3]) Ægir, **19**, 1957; Rit Fiskideildar, **2** (5), 1958.

[4]) Náttúrufræðingurinn, **4**, 1957; Rit Fiskideildar, **2** (6), 1958.

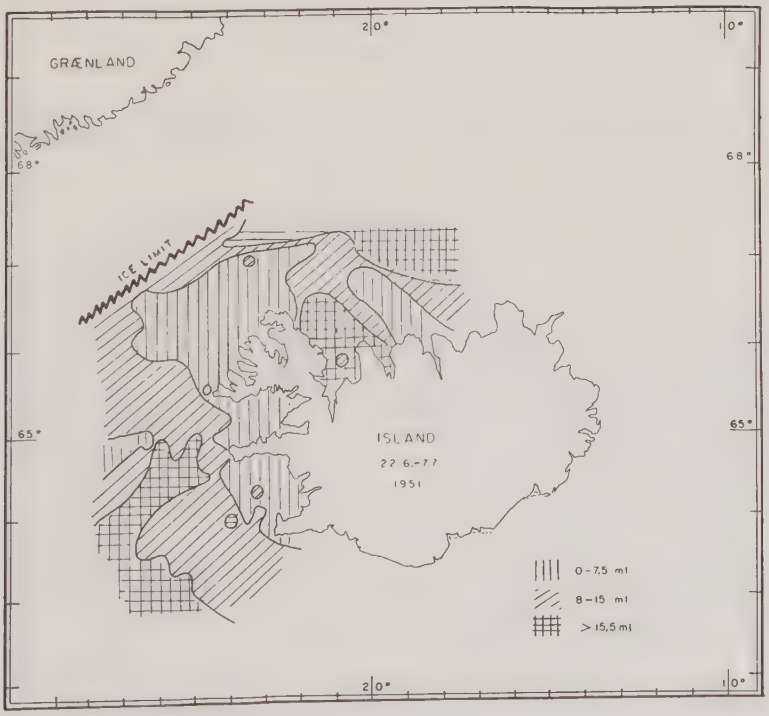


Figure 5. The density of zooplankton in Icelandic waters (Hensen net 50–0 m) in the period 22. June to 7. July, 1951. (Reproduced from EINARSSON, 1951).

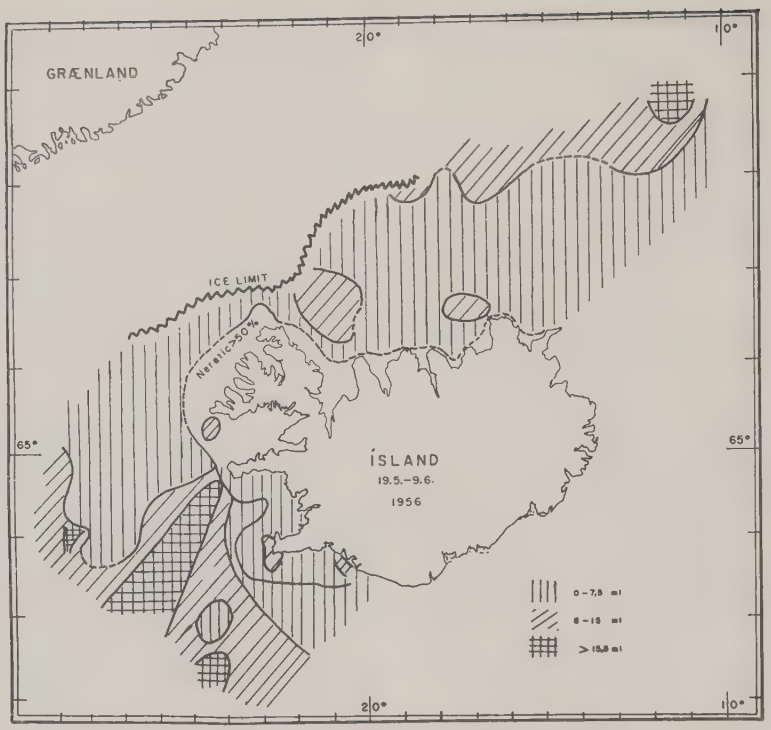


Figure 6. The density of zooplankton in Icelandic waters (Hensen net 50–0 m) from 19. May to 9. June, 1956.

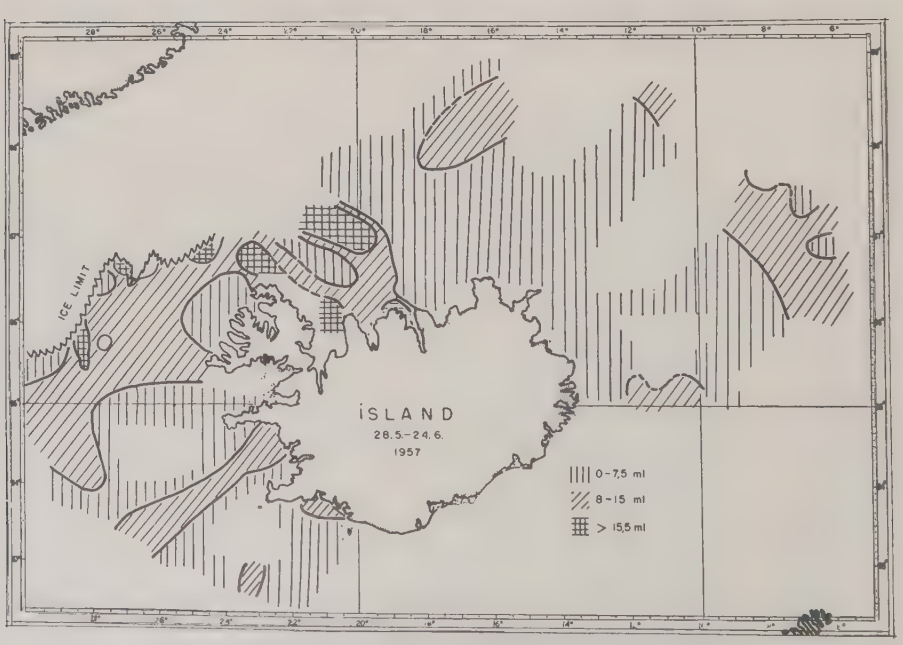


Figure 7. The density of zooplankton in Icelandic waters (Hensen net 50–0 m) from 28. May to 24. June, 1957.

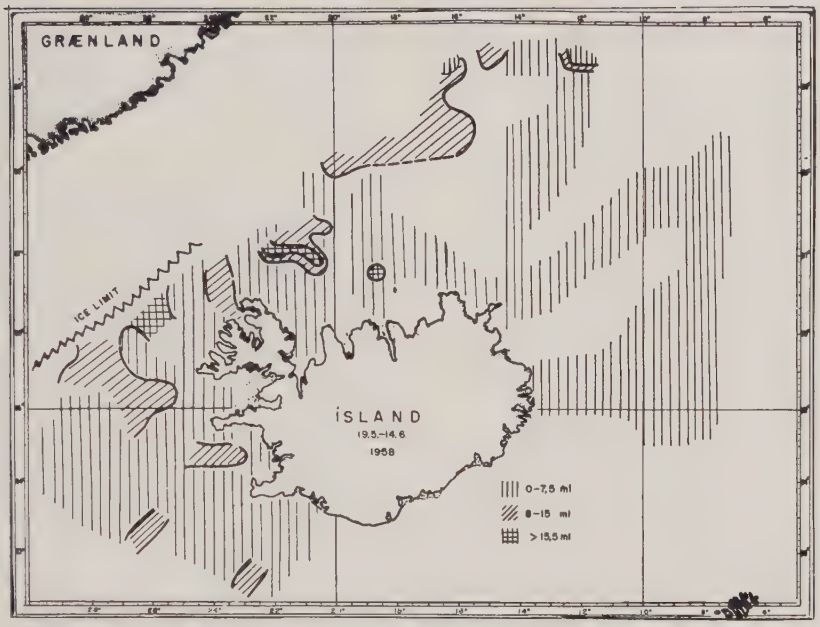


Figure 8. The density of zooplankton in Icelandic waters (Hensen net 50–0 m) from 19. May to 14. June, 1958.

therefore a mixture of local zooplankton and zooplankton carried into this region by the North Icelandic Irminger Current.

INGVAR HALLGRÍMSSON

Plankton Investigations from Aberdeen in 1958

Phytoplankton

During the period March/April the Faroe-Shetland region showed a clear demarcation between large numbers of *Chaetoceros debilis* on the Faroes side and *Thalassiothrix nitzschioides* and *Halosphaera* off the Scottish coast and Shetland. The survey off the southern coastal plateau at Iceland was too early for the spring outburst although some *Ch. decipiens* were present at nearly every station.

In June the waters around Faroe and between Faroe and Shetland were dominated by *Ch. debilis* whilst at the western end of the Faroe Channel *Ch. atlanticus* and *R. styliformis* were associated with *Salpa fusiformis*. *Ceratium compressum*, a rare visitor to Scottish waters, was found at both ends of the Faroe Channel in June and on the Faroe-Iceland Ridge in July and August. In these later months diatom concentrations were found only off the extreme south-west of Iceland with *R. styliformis* dominant and associated with concentrations of *C. fusus*, while *C. tripos* dominated the southern plateau.

R. styliformis became the dominant form in the period September/October in the eddy around the Faroes whilst to the north-west of Faroe *Nitzschia seriata* was the main constituent of a community that was essentially the same as in the offshore waters west of Scotland. The community nearer the Scottish coast, with *C. tripos*, *Globigerina* and salps, continued through the Faroe Channel to the northern North Sea.

T. LOVEGROVE

Zooplankton

(a) The Faroe Channel area

March/April: *Calanus* and other copepods, euphausids and crustaceous plankton generally were scarce in the oceanic area but moderately abundant to the north-west and west of Faroe and on the eastern side of the Faroe-Shetland Channel. There was a marked legacy of the winter inflow still present at the south-west entrance to the Faroe Channel, with a fair proportion of Lusitanian species such as the siphonophores *Vogtia spinosa*, *V. pentacantha*, *Lensia fowleri*, and *Hippopodius*. One specimen of *Sagitta decipiens* was also found. Although some of the Atlantic element was present as far as the north-west of Shetland no Lusitanian species were found there.

June: In general *Calanus* had considerably increased, except in the main path of oceanic water between Faroe Bank and the Wyville Thomson

Ridge where it was still scarce. In this area, however, there was a moderately rich crustaceous element in the deeper water (250 m) with *Pareuchaeta norvegica*, *Calanus hyperboreus*, *Eucalanus*, etc. In the upper layers plankton was poor with *Lensia conoidea* and medusae such as *Laodicea* and *Turris*. *Salpa fusiformis* was present south of the Wyville Thomson Ridge and also north-west of Shetland, but it was not found in the northern part of the Faroe Channel. The medusa *Ptychogena lactea* was found at 20 m depth at 60°23½'N, 7°49½'W, an arctic species not previously recorded from this area although RUSSELL in his monograph says that it "may yet be found to occur in deep water off the British Isles".

September: *Calanus* was reduced in numbers except to the north-west of Shetland, and the south-western end of the Faroe Channel became flooded with oceanic plankton from the Atlantic, dominated by *Arachnactes*, *Collozoum* etc.; *Salpa fusiformis* was present in small numbers only except near Shetland. Although a distinct Lusitanian fauna (with the siphonophores *Bassia*, *Rosacea*, and *Hippopodius*) was present in September off the Scottish west coast (see p. 58), there was only slight evidence of its penetration into the Faroe Channel but this included a unique record of one specimen of the siphonophore *Amphicaryon acaule* from 60°23½'N, 7°49½'W on 23. September from 250 m depth. *Aurelia* and *Cyanea* were abundant between Faroe and Shetland.

November: Sampling was restricted to the shelf area north of the Butt of Lewis, i.e., to the south of the area defined as Distant Northern Seas. Here *Calanus* was fairly abundant and *Salpa fusiformis* was still present in small numbers.

(b) The Faroe-Iceland Ridge

March: *Calanus*, with *Sagitta elegans* was common only in subsurface waters near the centre of the ridge and scarce elsewhere where plankton was poor with some *Physophora* and *Beroe*. A specimen of *Sagitta hexaptera* was taken in 62°31'N, 9°46'W on 21. March.

September: *Calanus* was still scarce in the region of the ridge but *Meganyctiphanes* and *Pareuchaeta* were abundant just off the Icelandic shelf. There was a distinct difference in the oceanic fauna from one end of the ridge to the other. At the Faroe end plankton was poor with a few radiolarians, *Collozoum* and *Thalassicolla*, part of the same community that extended across Faroe Bank and the northern part of the Faroe Channel. Centrally over the ridge *Aurelia* and *Cyanea* dominated with a few *Salpa fusiformis* and *Sagitta serratodentata*, but to the north-west, before the area of rich *Meganyctiphanes* near the Icelandic shelf, there was a community of *Limacina*, *Pareuchaeta norvegica*, *Stylocheiron*, *Sagitta maxima*, and *Eukrohnia hamata*.

(c) South of Iceland

March/April: On the shelf, especially towards the west, fish eggs were abundant and there were ripe capelin in tow nets. Crustaceous elements, including *Calanus*, were few except near the junction with the Faroe-Iceland Ridge. *Physophora* was widespread both on and off the shelf. In the offshore waters *Calanus* was more common, with euphausids, *Rhincalanus*, *Pareuchaeta norvegica*, and small cephalopods.

August/September: On the shelf *Calanus* was abundant at the western end, off Reykjanes, and also near the junction with the Faroe-Iceland Ridge at the edge of the shelf only, megalopa larvae being common in the shallower water. Elsewhere plankton was poor with *Beroë*.

In the deeper areas offshore south of Iceland plankton was richer with abundant *Calanus*, *Pareuchaeta*, euphausids, *Clione*, etc., and a very dense and extensive patch of *Themisto* occurred to the east of the Reykjanes Ridge. The medusae *Aglantha* and *Laodicea* were much more common to the south-east.

General

The plankton data suggest that:—

1. The water around Faroe was only slightly affected by oceanic inflow, and was more or less self-contained throughout the year.
2. During the early months of the year only Atlantic water penetrated through the Faroe Channel although a Lusitanian community existed at the western end.
3. It was not until autumn that Lusitanian fauna entered the Faroe Channel and it then extended along the edge of the continental shelf overflowing on to the shelf north of Scotland.
4. West of the British Isles, beyond the Lusitanian fauna, was a community of Atlantic species which extended northwards towards the Faroe-Iceland Ridge in September.
5. The Icelandic shelf water was also more or less self-contained.
6. In 1958 less Atlantic water affected the Icelandic area than in 1957.
7. Although there was some evidence of boreal influence in deep water across the Faroe-Iceland Ridge, in the early part of the year, this was negligible in September.

J. H. FRASER

B. Near Northern Seas

Plankton Investigations from Aberdeen in 1958

Phytoplankton

During November 1957 phytoplankton in Scottish coastal waters south of 57°N was about normal, the dominant species being *Thalassiothrix nitzschioides*, while to the north phytoplankton was very sparse. Offshore waters contained *Rhizosolenia* spp. with *Ceratium macroceros* in both November and December.

In February 1958 *Skeletonema costatum* dominated the Moray Firth and coastal waters, and *Thalassiothrix nitzschioides* the offshore waters except in a core of water from the north which contained *Halosphaera*, *Chaetoceros*, and *Coscinodiscus* spp. Over the Norwegian Deeps in the early part of April *Skeletonema* was dominant, followed by *Chaetoceros debilis* which was also present in May near Fair Isle. *Chaetoceros decipiens* occurred in Shetland waters in May whilst on Fladen *Nitzschia seriata* was dominant and associated with large numbers of zooplankton.

In early summer the sampling showed the main diatom concentrations to be east of 0°, with N. *seriata* in the north while in the south *R. styliformis* occupied the eastern part and *Chaetoceros* spp. the western part of the northern North Sea. Northwest of Shetland *C. debilis* was the dominant species but to the west, in the area of salps, *C. atlanticus* and *R. styliformis* were common. A rare oceanic visitor to Scottish waters, *Ceratium compressum*, was also found there. In July *R. styliformis* appeared to the north of Shetland as the water containing salps and *Cosmetira* moved into the area, while a tongue with *R. alata gracillima* extended into the Moray Firth. *Ceratium longipes* was then dominant generally in the northern North Sea, with *R. alata* and some radiolarians (*Acanthometron*).

Sampling in the period September to October west of the British Isles showed that phytoplankton in the open ocean there was poor, but nearer the Irish shelf *R. styliformis* was found associated with a Lusitanian zooplankton. The inflow to the north North Sea at this time contained *C. tripos* with *Globigerina* and *Salpa fusiformis* while in Scottish coastal areas of the northern North Sea and Moray Firth *R. alata* was still dominant.

The October and November oceanic inflow carried *Halosphaera*, *Globigerina*, and *Collozoum* with *Ceratium fusus* and *C. tripos* towards the Norwegian coast and the northern North sea generally, but the indigenous water contained little phytoplankton.

Both the spring and autumn phytoplankton outbursts were qualitatively and quantitatively those of an average year.

T. Lovegrove

Zooplankton

Calanus was richer than normal in the northern North Sea during the autumn of 1957 and some of this community remained throughout the winter in the sub-surface layers, although the surface layers were poor and contained some oceanic species north of 57°N. *Calanus* became particularly abundant in April to the west of the Norwegian Deeps and in the Shetland area. By mid-summer this community was pushed southwards and divided by a mixed inflow from the west, but *Calanus* and euphausids were still plentiful in the Fair Isle region and Moray Firth, and continued so until September and October.

In the spring of 1958 *Oikopleura labradoriensis* was plentiful and whiting were reported feeding on it in the Shetland area, and young saithe also fed on it in Aberdeen Harbour. Other unusual reports on plankton as food for demersal fish were made in June off the east Scottish coast when haddock were feeding on the siphonophore *Agalma* — or more probably on the clumps of *Calanus* entangled in its tentacles, and in September when cod were feeding on salps west of Orkney.

In the spring the dominant chaetognath in the Norwegian Deeps was *Sagitta setosa* but *S. elegans* was dominant in the Scottish area. As the year progressed *S. setosa* was pushed further to the south, as far as 58°30′N by August, and none were found in November. *Salpa fusiformis* reached the west of Shetland by June but planktonic evidence suggests that there was then no inflow into the North Sea of oceanic water from the Faroe Channel although shelf fauna, from the Minch and north Scottish coastal area, gradually replaced the spring *Calanus* by a mixed fauna with many small medusae. Only after July did the salps penetrate, when they did so very quickly indeed and had spread over large areas of the north North Sea by September, reaching the Norwegian Deeps and coastal zone of Norway near Bergen by November.

Investigations off the west of Scotland and Eire in September and October showed that an extensive band of Lusitanian fauna existed off the edge of the shelf from the region of Porcupine Bank (the southern limits of the investigation) to the southwest of the Faroe Channel. The most significant of

these species was the salp *Thalia democratica* which has not been reported in such abundance from this area since 1884 and 1904. It was accompanied by the salp *Iasis zonaria* and a number of siphonophores, *Bassia bassensis, Eudoxoides spiralis, Rosacea plicata, R. cymbiformis, Vogtia spinosa,* and the radiolaria *Collozoum* (which was often very abundant), and *Thalassicolla*; all of these reached the entrance to the Faroe Channel in September. A unique record was that of the siphonophore *Amphicaryon acaule* at 60°23½′N, 7°49½′W on 23. September. A single specimen of the salp *Thetys vagina* was found with *Velella* at the southern limits of the sampling, 53°20′N, 14°40′W on 2. October.

There was no planktonic evidence of the penetration of this Lusitanian fauna into the Faroe Channel in September although the inflow of Atlantic species (e.g., *Salpa fusiformis*) had been so marked in the summer. By November, however, it was found along the edge of the Scottish shelf, and overflowing on to it, the most noteworthy examples being a single specimen of the salp *Pegea confoederata* to the north-west of Orkney, a new record in Scottish waters, and *Sagitta lyra* to the north-west of Shetland.

Summarized, the inferences for the plankton analyses are:—

1. A rich *Calanus* population was present in the northern North Sea in spring, but was replaced in the Shetland area by a mixed shelf fauna in early summer except near Fair Isle.

2. Indigenous North Sea water extended northwards on the eastern side of the northern North Sea early in the year but was pushed south as the year progressed.

3. A marked inflow of Atlantic fauna penetrated the Faroe Channel in early summer but was held up at Shetland and did not penetrate into the North Sea until after July. It affected large areas of the northern North Sea by September and October and reached the Norwegian coastal area in November.

4. A distinct and particularly interesting tongue of Lusitanian fauna reached northwards along the western edge of the continental shelf to the Faroe Channel in September but did not penetrate the Channel until November when it did so along the edge of the shelf and between the coastal belt and the Atlantic fauna.

5. Several interesting reports of demersal fish feeding on plankton organisms were made during the year.

J. H. Fraser

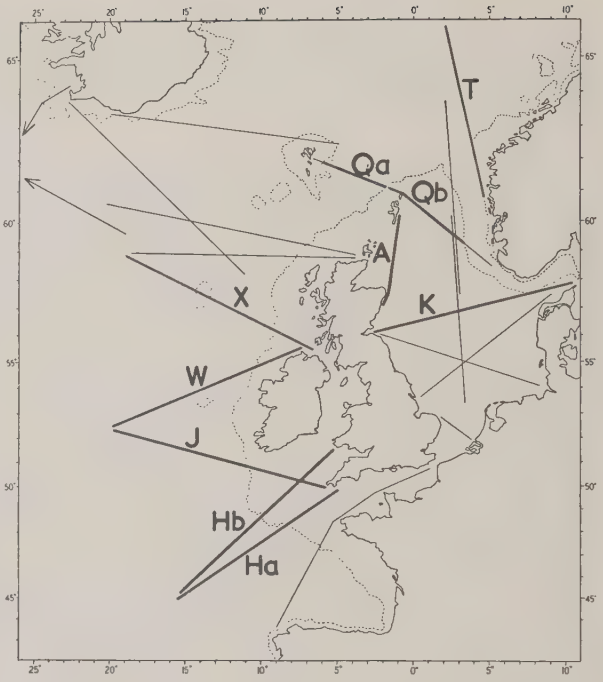


Figure 9. A chart showing the routes along which the Continuous Plankton Recorder was towed during 1958. Routes used for the histograms in the figures which follow are indicated by a thick line; in the figures and in the text they are referred to their code letters, H, J, W, X, Qa, T, Qb, A, and K.

The Continuous Plankton Recorder Survey: Plankton around the British Isles during 1958

(Figures 9–17)

The Plankton Recorder Survey was continued, on a similar scale to that of 1957, over the north-east Atlantic and the North Sea. Figure 9 shows the routes from which samples were collected during 1958 at the standard depth of 10 metres.

Brief summaries of the results obtained during each year of the survey have been published in the *Annales Biologiques*. The present summary for 1958 is presented in the same way as that for 1957 (Ann. Biol., **14**: 67—69). Changes in the rotation of duty at Ocean Weather Stations resulted from the withdrawal of one of the ships for major repairs. This restricted sampling on routes H and J to the period February to June. The V route, running westwards from the extreme north of Scotland was also affected; only two records were obtained on the normal route, the remaining four records taking an unusual course from Shetland to Iceland. For these reasons the V records are omitted from the present summary. It has been possible to restore the A

route, running from Aberdeen to Shetland; this route was included in the summaries for the years 1948 to 1954 but subsequent sampling was infrequent and the results were omitted from the summaries; in 1958 the sampling improved and seven records were obtained.

As before, results from routes Ha, Hb, and J are combined, and the Q route is divided into Qa (sampling over the deep water between the continental shelf and the Faroes) and Qb (running over the North Sea plateau). In addition to the standard routes shown by thick or thin lines in Figure 9, extra samples were taken from F.R.V. "Explorer" (Scottish Home Department, Aberdeen) and from R.V. "Sarsia" (Marine Biological Association, Plymouth). Further details of the plankton collected on particular records will be supplied on application to the Officer-in-Charge, Oceanographic Laboratory, Scottish Marine Biological Association, 78 Craighall Road, Edinburgh 6, Scotland.

Figure 10 shows the superficial estimation of phytoplankton based on the green colouration of the filtering silk. As in previous years, there was evidence that the spring outburst was earlier in the North Sea (March on the K route) than that over the deep Atlantic (April or May on the H, J, W, X, and Qa routes) where the spring outburst was about a month later than in 1957. In the spring there was a rich crop of diatoms in the extreme northern North Sea (route Qb) and in the Norwegian Sea (route T) where *Thalassiosira* spp., *Chaetoceros* spp., and *Nitzschia seriata* were the most abundant forms. In July and August in the northern North Sea (routes Qb, A, and K) *Rhizosolenia alata* Brightwell var. *alata* was abundant; this was the form sometimes described as *R. alata* var. *gracillima* (Cl.) Grunow. Much of the colouration of the silk in October and November on the K route was caused by *Ceratium* spp. but there were also unusually large numbers of diatoms for this time of year. Among these diatoms, the occurrence of relatively large numbers of *Dactyliosolen mediterraneus* and a few *Rhizosolenia alata indica* suggests the possibility that there may have been a late inflow of mixed oceanic and western coastal water into the North Sea; both these diatoms penetrated further south than usual, being found on the Leith-Hamburg route in November.

Total copepods (Figure 11) were markedly less abundant than usual, being almost as scarce as in 1955 which was, previously, the year with the lowest numbers. The scarcity of copepods in 1958 was evident over the whole area of the survey but especially so over the deep Atlantic waters (routes H, J, W, X, and Qa). The reduction in numbers was

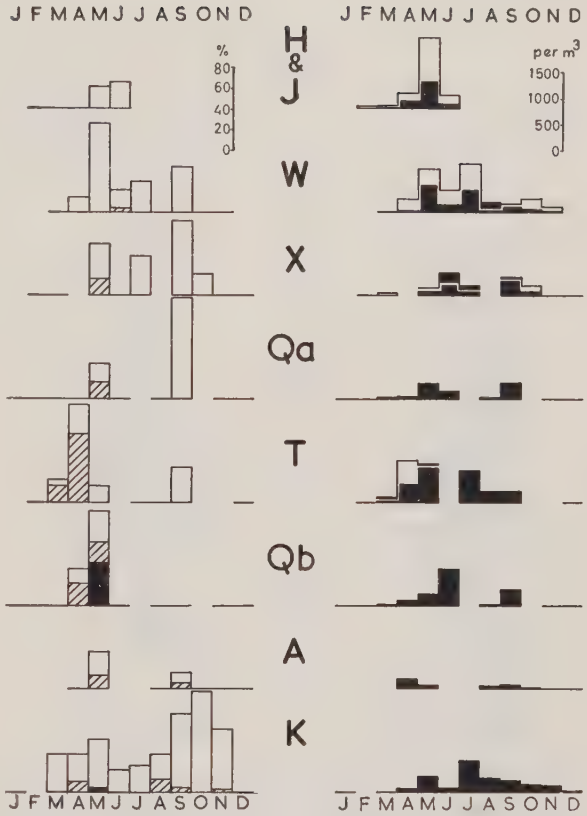


Figure 10 (left). A month-by-month estimate of the quantity of phytoplankton on the Recorder routes shown by a thick line in Figure 9. The open part of the histogram shows the percentage of the filtering silk which was coloured "pale green", the hatched part coloured "green", and the blacked-in part "dark green"; estimated by comparison with an arbitrary colour scale. A gap in the base line indicates that there were no samples in that month.

Only that part of the record taken over deep water, outside the 100 fathom contour, has been included on routes H, J, W, X, Qa, and T. The whole of routes A and K have been used but only that part of Qb which sampled the shallow North Sea plateau.

Figure 11 (right). Histograms showing, month-by-month, the numbers of Total Copepoda (all species combined) taken on the Recorder routes shown by a thick line in Figure 9. The histograms represent the number of copepods per cubic metre of water sampled along the whole length of tow on routes A and K, along the deep Atlantic part of route Qa and the North Sea plateau part of Qb. The two parts of the tows which lay on either side of the 100 fathom contour on routes H, J, W, X, and T have been separated, the solid histogram showing the numbers over the deep water and the open histogram over the shallow water of the continental shelf. A gap in the base line indicates that there were no samples in that month.

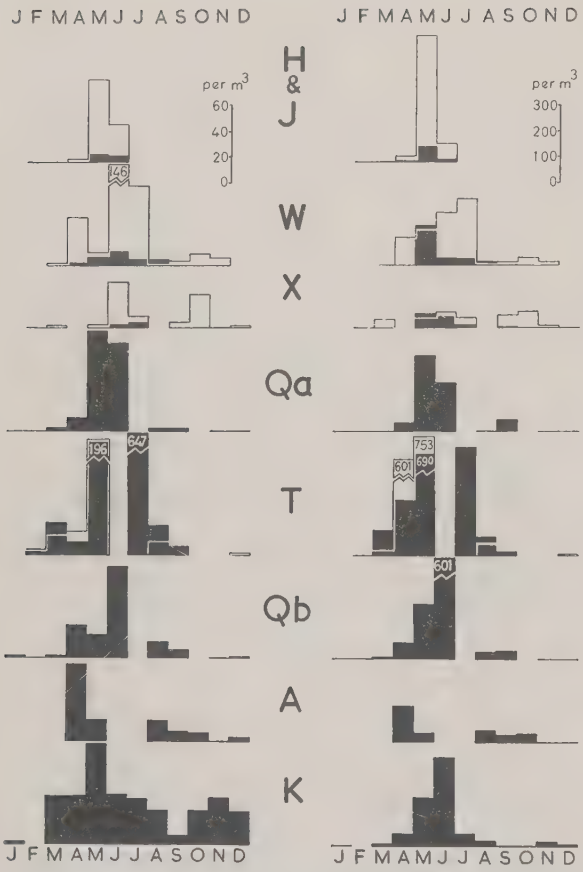


Figure 12 (left). Histograms showing, month-by-month, the numbers of Large *Calanus finmarchicus* (copepodid stages V and VI) taken on the Recorder routes shown by a thick line in Figure 9. Details as in Figure 11.

Figure 13 (right). Histograms showing, month-by-month, the numbers of *Calanus finmarchicus* (all stages combined) taken on the Recorder routes shown by a thick line in Figure 9. Details as in Figure 11.

most noticeable in the small copepods such as *Paracalanus*, *Pseudocalanus*, and *Acartia*. On the other hand, *Calanus finmarchicus* (Fig. 13) was probably slightly more abundant than usual. (No attempt has been made here to separate the "*finmarchicus*" and "*helgolandicus*" forms of this copepod.) As in previous years, the highest numbers of *Calanus* were found on the T route where "all stages combined" exceeded 750 per cubic metre in May, a level comparable with that in the period 1950 to 1953 and appreciably higher than the numbers found in 1954 and 1955. The *Calanus* populations were restricted to the late spring and summer; there were few signs of an autumnal generation although unusually high numbers of stages V and VI persisted throughout the year on the K route.

Metridia lucens (Fig. 14) was rather more numerous than in the last few years but numbers were appreciably smaller than in the period of great abundance, 1950 to 1953. In the North Sea, *Metridia* was very scarce until the last two months of the year.

In the Recorder samples at a depth of 10 m, the *Thaliacea* (Fig. 15) were almost all *Salpa fusiformis*. Moderate numbers of *Thalia democratica* were found, as in previous years, in September and October to the west of Ireland and Scotland (routes W and X). The more exotic salps and doliolids and *Dolioletta*

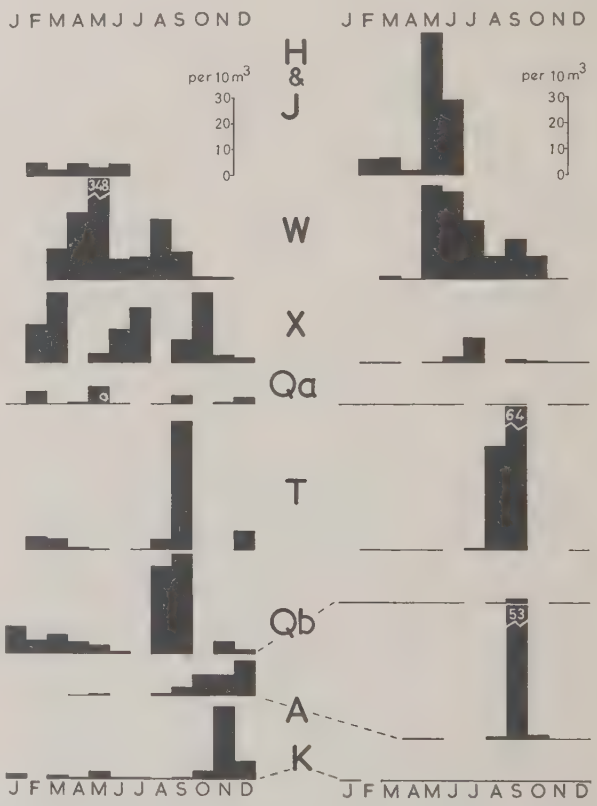


Figure 14 (left). Histograms showing, month-by-month, the numbers of *Metridia lucens* taken on the Recorder routes shown by a thick line in Figure 9. The histograms represent the number of organisms per ten cubic metres of water sampled along the whole length of routes A and K and the North Sea plateau part of Qb. Only that part of the record taken over deep water, outside the 100 fathom contour, has been used from routes H, J, W, X, Qa, and T. A gap in the base line indicates that there were no samples in that month.

Figure 15 (right). Histograms showing, month-by-month, the numbers of *Thaliacea* taken on Recorder routes shown by a thick line in Figure 9. Details as in Figure 14.

gegenbauri were present in very small numbers, or were absent. *Salpa* appeared slightly later than usual off the western entrance to the English Channel; thereafter the distribution followed its accustomed path northward between the Western Banks and the continental slope until, in August, it penetrated into the North Sea where numbers, later increased (September on route A) and the distribution extended southwards to latitude 57°N. This late-season penetration of salps into the North Sea is reminiscent of that which occurred in 1955 when very large numbers of aggregate stages were carried into the Norwegian Sea. The population found in the Norwegian Sea in August and September of 1958 (T route) comprised both solitary and aggregate stages.

Large specimens of *Limacina retroversa* (Fig. 16) were scarce in the Atlantic except for a short-lived population in May on route W. They appeared in July on route T and in September in the North Sea, on routes Qb and A, one to two months later than in 1957.

Clione limacina was exceptionally scarce over the deep waters of the Atlantic and very few specimens were taken over the continental shelf. The population on routes Qa, A, and K in August may have been derived from the earlier stock on the Atlantic shelf but it seems possible that it resulted from breeding of a resident population in the northern North Sea. The small numbers found on the K route in May almost certainly arose by local breeding and the remaining peaks in August and October were about two months later than the equivalent peak in 1957.

From a brief inspection of the preliminary results of the Continuous Plankton Recorder Survey in 1958 it is concluded that, although the plankton around the British Isles was in many respects similar to that of 1957, the major difference was that, in the second half of 1958, most of the expected events in the plankton were one to two months later than in 1957. The oceanic and western coastal penetration into the North Sea was appreciably less in 1958, than in the period 1952 to 1954. Such inflow as did occur came very late in the season, in late August and September. That this late inflow did not penetrate far south into the North Sea is suggested by the distribution of such species as *Salpa fusiformis*, *Metridia lucens*, and *Clione limacina*; for example *Clione* penerated to Lat. 55°N in 1958 compared with 52°30′N in 1954. *Clione* appeared relatively late (in June) on the W route, compared with March in the years of strong inflow into the North Sea. In 1958, as in 1957, *Clione* and young *Limacina* were almost absent from the Atlantic west of the 100 fathom contour where in 1952 to 1954 they were most abundant.

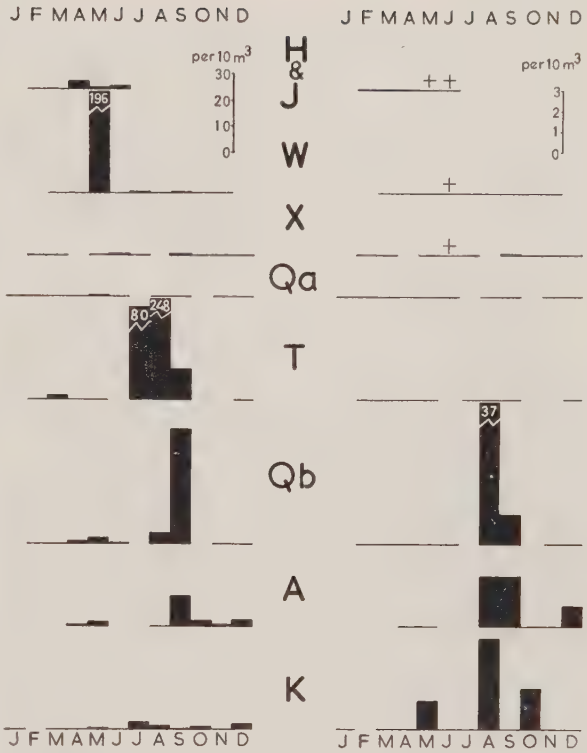


Figure 16 (left). Histograms showing, month-by-month, the numbers of *Limacina retroversa* larger than 1 mm taken on the Recorder routes shown by a thick line in Figure 9. Details as in Figure 14.

Figure 17 (right). Histograms showing, month-by-month, the numbers of *Clione limacina* taken on the Recorder routes shown by a thick line in Figure 9. Crosses indicate the presence of small numbers of *Clione* over the continental shelf on the Atlantic routes; other details as in Figure 14.

The plankton of the Scottish east coast herring fishing grounds has been studied since 1947, using the Hardy Plankton Indicator. The results support the major features of the Recorder collections. In general terms, the summer months during the period 1947 to 1951 were characterized by typical neritic and North Sea plankton; from 1952 to 1954 there was an invasion of indicators of the mixture of Atlantic oceanic and shelf water; from 1955 to 1958 the shelf plankton dominated the fishing grounds with a scarcity of extreme neritic and oceanic plankton.

R. S. Glover and Beatrice I. Barnes

Investigations of the Bottom Fauna in the Eastern Part of the German Bight, 1958

(Table 1)

The qualitative and quantitative bottom fauna investigations carried out in the eastern part of the German Bight since 1949 were continued in 1958, when 21 stations were worked by the R/V "Uthörn". In the spring and autumn of 1958 42 samples were taken in each season by means of a 1/10 m² van Veen grab.

Noteworthy features for the year were: (a) the total biomass was the same in spring and autumn; (b) so were the biomass and numbers of lamellibranchs; (c) the autumn increase in numbers of polychaetes was rather slight. (Table 1).

A decrease was observed in the numbers of lamellibranchs and polychaetes as compared with 1957. Both of these classes of invertebrates are most important as fish food. In the autumn of 1957 a noticeable increase in the numbers of bottom animals was observed, possibly caused by very favourable weather conditions. In the autumn of 1957 the polychaetes reached a stock maximum higher than at any time since this series of investigations commenced (1949). Also the lamellibranchs attained the highest stock counts since 1952 (see Ann. Biol., **12**: 70—72). After the winter of 1957/58[1]) which apparently was not so favourable as the previous one, but hardly can be considered a restricting factor in bottom fauna development (as shown by the comparatively high abundance of the temperature-sensitive Echinocardia) much higher stock density was expected in 1958.

Apart from the natural losses caused by enemies (several invertebrates and fishes) developing equally well under the favourable conditions, the decrease of the stock of benthos in 1958 is almost certainly due to the quality of the bottom and the hydrographic conditions in the German Bight, which even under the most favourable conditions (especially climatic) do not allow for an increase in benthal stock density above the production potential of this area.

Amongst the lamellibranchs only *Angulus fabula* showed a slight increase; on the muddy stations of the "Otzumer Balje" section *Nucula nitida* showed higher stocks counts in the spring and autumn of 1958 than in the preceding year. The stocks of all other lamellibranchs diminished. The abundance of *Montacuta bidentata* which formed the main part of the very rich stock of lamellibranchs in the autumn of 1957, revealed in spring 1958 only half, and in autumn about one-sixth of the values of the previous year. The stock numbers of *Phaxas pellucidus* had also fallen off by about 50%.

The exuberant growth of the lamellibranch stocks in 1956 and 1957 was followed by an increase of *Lunatia nitida*. In the autumn of 1958 the average stock numbers of this species of Naticidae reached an amount exceeding anything observed since 1952/53 after the lamellibranch maximum of 1950/51 (see Ann. Biol., **11**: 63). *Hydrobia ulvae*, which occurred in large quantities outside the mouth of the river Elbe (station "Otzumer Balje I") (over

[1]) According to the surface water temperatures measured near List/Sylt the winter of 1957/58 had six short frost periods (longest 8 days) at intervals of two weeks during the period mid-December 1957 to the second decade of March 1958.

Table 1.

	1949	1950		1951		1952		1953		1954		1955		1956		1957		1958	
	Aut.	Spr.	Aut.	Spr.	Aut.	Spr.	Aut.	Spr.	Aut.	Spr.	Aut.	Spr.	Aut.	Spr.	Aut.	Spr.	Aut.	Spr.	Au
Average numbers on $^1/_{10}$ m² at all stations																			
Lamellibranchs	50.6	27.3	139.4	102.1	71.1	44.7	53.8	51.5	62.7	17.3	27.6	30.4	52.9	26.6	37.0	34.6	74.9	53.5	52.
Lunatia nitida	—	—	—	0.1	0.2	0.7	0.6	0.2	0.6	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.
Polychaetes	28.5	7.9	16.9	20.7	26.5	17.0	71.4	33.1	57.0	14.7	91.4	40.8	168.5	54.9	85.3	45.4	195.7	58.6	90.
Crustacea	14.2	3.0	7.9	8.1	15.0	9.6	35.1	14.0	21.3	9.8	25.0	6.7	20.1	8.6	20.0	9.9	25.4	15.2	26.
Echinoderms	8.8	2.9	10.1	12.8	12.4	9.6	11.0	5.8	13.0	3.4	9.0	4.9	32.3	5.8	6.6	6.2	16.2	4.4	22.
of which *E. cordatum* ..	5.0	1.0	4.9	5.1	4.2	2.8	4.1	2.6	3.2	1.2	1.8	1.0	17.6	0.5	0.6	0.4	6.1	1.3	13.
Average total stock on $^1/_{10}$ m² (biomass in cm³)																			
E. cordatum excepted ..	6.1	3.3	7.1	7.5	4.8	3.2	5.0	5.1	5.9	3.0	4.6	3.2	5.0	2.7	4.6	4.8	8.1	4.9	4.
Average stock on $^1/_{10}$ m² (biomass in cm³)																			
Lamellibranchs	2.8	1.5	4.7	5.3	2.6	2.0	2.7	3.3	3.4	1.8	2.0	1.9	1.6	1.3	1.7	2.2	3.2	2.6	2.
Polychaetes	1.3	0.6	1.6	1.5	1.1	0.7	1.5	1.1	1.6	0.7	2.2	1.1	2.5	1.1	2.0	2.1	4.1	1.8	1.

7,000 specimens per 1/10 m²) when these investigations started, has now entirely disappeared. The sieve residue of the bottom grab catches contains only empty shells of this small gastropod.

The most frequently occurring polychaetes at all stations and the most important as fish food are the following: *Spiophanes bombyx*, *Pectinaria koreni*, *Lanice conchilega*, *Nephthys hombergi*, *Scoloplos armiger*, and *Magelona papillicornis*. The last form an exception with respect to distribution, since it lives in sandy bottom only, avoiding mud. In the autumn of 1957 the main bulk of the stock of polychaetes consisted of *Spiophanes* contributing over 54% (on an average 105 specimens per 1/10 m² at each station). In the spring of 1958 only about one-sixth, and in autumn about one-tenth of the 1957 numbers of *Spiophanes* were recorded. All other polychaetes showed either almost similar values, or only very small variations in the spring and autumn of 1958. *Lanice conchilega* reached an abundance in the autumn of 1958 which amounted to nearly double that of the preceding year and formed with 22% the polychaete species most frequently found in the bottom grab catches in that season. The stock of *Lanice* consisted mainly of young specimens which accounts for the small biomass of polychaetes in the autumn of 1958.

As already mentioned in previous contributions the rather constant abundance of crustacea is noteworthy. The amphipods *Urothoë poseidonis* and *Bathyporeia guilliamsoniana* occur frequently in the grab samples from sandy localities. *Ampelisca brevicornis* which occurs in the whole area in different types of bottom, from pure sand to mud, fluctuates largely in abundance from year to year. In the autumn of 1957 *A. brevicornis* was very frequently encountered (369 specimens in all samples), in the autumn of 1958, however, there were only a few specimens (14 in all samples). The Cumaceae *Diastylis rathkei*, *D. bradyi*, and *Iphinoë trispinosa* were found more frequently in the grab samples of the autumn of 1958 than in the preceding years.

Following the decimation of the stock of echinoderms brought about by the very severe winter of 1955/56, the numbers of *Echinocardium cordatum* reached a very high level after the mild winter of 1956/57 and the medium winter of 1957/58. The numbers were only slightly below the maximum observed during this series of investigations, viz., in the autumn of 1955. About 95% of the Echinocardia found in the autumn of 1958 were up to 10 mm long. While *Ophiura texturata* and *O. albida* suffered a depletion in 1958, *Amphiura filiformis* which had totally disappeared in the area investigated during the cold period of 1946/47, gradually recovered (since the spring of 1955), and in the autumn of 1958 it reached the highest numbers hitherto recorded on the muddy grounds of the stations around Helgoland.

E. Ziegelmeier

C. Baltic-Belt Seas

Quantity and Biomass of Zooplankton (Crustacea) in the Baltic Sea and the Gulf of Riga in 1958

(Tables 1–2)

Values of zooplankton production in the Baltic in 1958 were lower than the long-term averages in the first half of the year and higher than those of the second half (Table 1). Low quantities and biomass of plankton in spring (May) are explained by a delay in the development of Crustacea caused by low water temperatures (in relation to the average long-term values) in the 0—50 m layer. At the same time the numerical strength and biomass of plankton in the Gulf of Riga in May were above normal owing to a favourable influence of intensified discharge of fresh water during winter and spring 1958, when the water drainage during the first five months of the year exceeded 150% of the normal value.

In August, September, and October the biomass and quantity of zooplankton were above the long-term values both in the Baltic and in the Gulf of Riga. Heightened planktonic production in the upper water layer in August—September was not caused by the development of *Cladocera*, as in previous years, but by the Copepodae species: *Temora* and *Acartia longiremis* in the Baltic, and *Eurytemora hirundoides* and *Acartia bifilosa* in the Gulf of Riga. (Table 2).

Dominating in the specific composition of plankton in the Baltic were: (a) the phytoplankton species *Aphanizomenon flos aquae, Gomphosphaeria lacustris* (in summer), *Thalassiosira baltica* (max. in spring), *Thalassiosira nana, Chaetoceros danicus, Ch.* sp., *Sceletonema costatum, Achnanthes taeniata* (in spring), *Microcystis pulverea* (in summer), *Dinophysis baltica, Peridinum pellucidum, Gonyaulax*

Table 1. Average numbers and biomass of zooplankton (crustacea) in the Baltic, 1958

Dates of sampling	0–25 m layer					25–50 m layer					50–100 m layer				
	Numbers per 1 m³		Biomass mg/m³		No. of years of obs.	Numbers per 1 m³		Biomass mg/m³		No. of years of obs.	Numbers per 1 m³		Biomass mg/m³		No. of years of obs.
	1958	1949–58	1958	1949–58		1958	1949–58	1958	1949–58		1958	1949–58	1958	1949–58	
February 7–16	—	2,370	—	83	3	—	1 580	62	—	2	—	1,045	—	48	2
April 4–20	(1,380)	2,340	(20)	—	3	(2,250)	1 410	64	—	3	(170)	440	(9.3)	—	2
May 11–14	3,520	(16,150)	28	88	6	4,150	3,500	30	33	6	4,550	3,470	31	50	6
August 5–7	15,790	12,280	326	245	5	15,290	6,910	339	214	5	6,480	4,610	176	163	5
October 28–31	7,640	6,260	131	119	5	4,600	4,200	123	116	5	3,970	3,300	154	134	5
November 2	(5,650)	8,040	(57)	—	2	(9,260)	5,220	(153)	—	2	(6,300)	5,000	(180)	—	2

Table 2. Average numbers and biomass of zooplankton (crustacea) in the Gulf of Riga, 1958

Months	0–20 m layer				20–40 m layer				Number of years of obs.
	Numbers per 1 m³		Biomass, mg/m³		Numbers per 1 m³		Biomass, mg/m³		
	1958	1948–58	1958	1948–58	1958	1948–58	1958	1948–58	
April	—	10,570	—	56	—	1,560	—	13	3
May	10,300	7,500	140	135	2,400	2,600	118	103	8
July	12,110	20,030	180	310	1,950	6,230	242	210	6
August	32,020	23,500	427	361	7,310	6,700	180	256	5
September	34,850	19,650	438	272	—	13,400	—	402	5
October	20,970	13,820	183	172	11,120	4,260	119	125	7

catenata (in spring), *Coscinodiscus Grani* (in autumn), *Coscinodiscus* sp.; (b) the zooplankton species: *Pseudocalanus elongatus, Temora longicornis, Acartia longiremis, Bosmina maritima, Evadne nordmanni, Podon polyphemoides, Synchaeta monopus, S. baltica, Fritillaria borealis, Aurelia aurita, Macoma baltica* (*larvae*).

In 1958, the plankton composition was affected by the lowered salinity of the water. Some brackish water adherents, e.g., *Sagitta elegans baltica, Oithona similis,* that were regularly observed in the Deeps of Gdańsk and Gothland during 1947—54, were encountered this year only in the area of Bornholm. On the other hand, some fresh-brackish water forms (*Microcystis pulverea, Gomphosphaeria lacustris*) were developing rapidly even in the southern Baltic area.

I. Nikolaev

Distribution and Biomass of *Furcellaria fastigiata* (Huds.) Lamour in the Baltic (Klaipeda-Shventoy Area)

(Figure 18)

Studies of the quantitative distribution and stocks of macrophytes were conducted, with participation of divers, in July—August 1955/56 in the area of Klaipeda-Shventoy.

Assessment of the quantitative distribution and a qualitative estimate of the macrophytes were made in five sections from Klaipeda northwards to Shventoy. The sections were run from the shore seawards in depths from 2 to 25 metres. The main object of the investigations was to locate the commercially important species *Furcellaria fastigiata* (Huds.) Lamour (see Figure 18).

It was observed that this alga grows on rocky bottom in the area investigated at depths of 3 to 14 m, and on mussel grounds at greater depths (14—25 m). In the areas of river discharge *Furcellaria* cease to grow as the water freshens and sandy grounds are formed. *Furcellaria* growing in shallow waters is smaller and thinner in appearance than that which grows at greater depths (14—25 m). This latter type is gristly with regular but more sparse dichotomous branching and is only slightly covered with epiphytes.

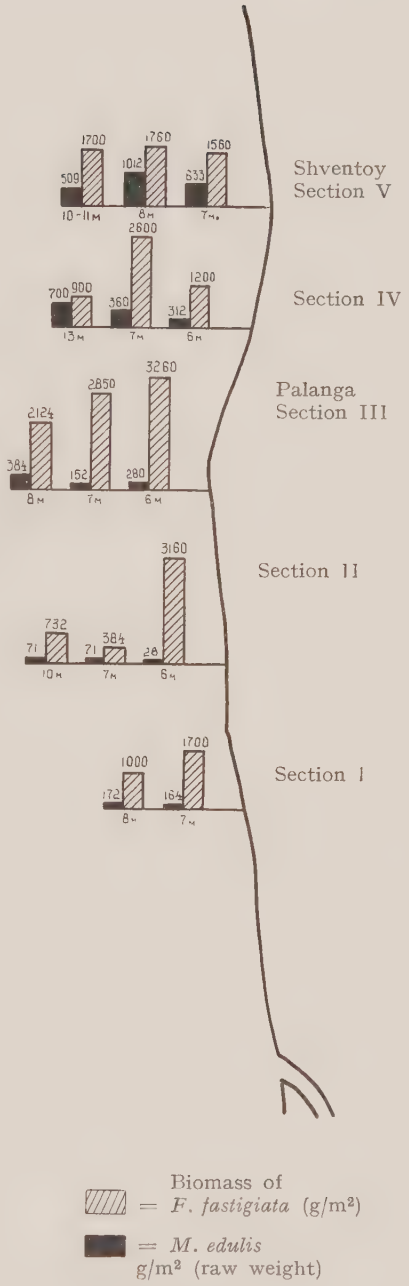


Figure 18.

Furcellaria from more shallow grounds is often covered with polyzoans and secondary epiphytes: *Ceramium diaphanum* (Lightf.) Roth and *Polysiphonia nigrescens* (Smith) Grev. Dichotomous branching in this type of *Furcellaria* is not so pronounced owing to the fact that when the branches are broken off in rough sea a whole set of new branches grow up again at the places of truncation making the alga more bushy in appearance.

During the survey it was observed that the biomass of *Furcellaria* increased from the first to the third section (see Fig. 18) where it reached a maximum of 3,260 g per square metre, but further northwards it decreased again. In most cases a decrease also takes place with depth.

The amount of biomass of *Mytilus edulis* attached to the *Furcellaria* was, however, distributed inversely in the five sections in question, reaching a peak towards the fifth section. In each section the number of mussels was also increasing with depth.

This increase in the quantity of mussels suppresses the growth of *Furcellaria*, reducing the biomass, and thus debasing the value of the weeds as an industrial raw material.

M. Kireeva

PART III.

THE FISH

A. Distant Northern Seas

Halibut

Danish Investigations in East Greenland

(Figure 1)

On the banks off Angmagssalik in East Greenland halibut were caught on long-lines during the period 22. August—8. September. Five long-lines with a total of 4,800 cod hooks and 2,600 halibut hooks were operated. The total catch consisted of 144 halibut, 43 cod, 16 *Anarhichas minor*, and 49 *A. denticulatus*, together with some few fish of no importance. Seventeen of the halibut were marked with the Petersen disk and the remainder were otolithed for age determination. In the fjords halibut were present in rather small quantities.

Out of 152 halibut, 75 were males and 77 females; the length frequency distribution given in 10 cm groups is shown in Figure 1.

P. M. Hansen

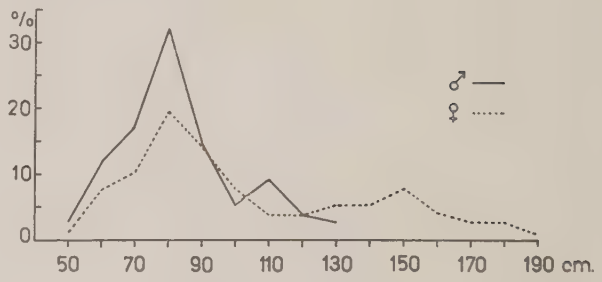


Figure 1. Length frequency distribution in 10 cm groups of male and female halibut caught off Angmagssalik in 1958.

Redfish

Danish Catches in West Greenland Fjords

(Tables 1–2)

In continuation of previous years' experiments fishing for small redfish with the shrimp trawl was operated in the Godthåb fjord (1 D) and the Tunugdliarfik fjord in the Julianehåb district (1 F).

Table 1. Length frequencies of redfish taken with the shrimp trawl by M/C "Adolf Jensen" in Godthåb fjord, 64°25′N, 50°19′W

Date, 1958	Number of hauls	Length in centimetres 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
April	2	—	1	3	35	157	124	55	174	177	59	50	30	50	80	47	26	27	38	27
May	1	—	1	7	39	211	203	62	151	218	86	34	52	41	65	58	37	28	24	13
July	2	—	—	—	6	32	45	25	20	47	42	25	14	13	11	10	9	10	10	8
October	1	—	1	2	3	16	77	88	33	56	142	94	39	39	52	48	80	69	47	54

Date, 1958	Number of hauls	Length in centimetres 24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	>40	Number of fish
April	2	15	7	7	6	3	3	3	—	—	—	2	2	—	2	—	1	—	5	1,216
May	1	the measurements of 104 specimens longer than 24 cm are absent																		1,434
July	2	2	—	1	3	3	2	—	6	2	—	4	3	6	3	5	8	7	12	394
October	1	43	32	15	11	18	10	10	9	7	8	9	11	9	8	9	3	2	8	1,162

Table 2. Length frequencies of redfish taken with the shrimp trawl by M/C "Immanuel" in Tunugdliarfik fjord, 60°56′N, 45°47′W

Date, 1958	Number of hauls	Length in centimetres 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
October	2	—	—	5	44	76	32	72	75	33	30	42	20	16	11	13	9	22	14	11
November ..	2	—	—	4	18	33	13	24	19	9	11	20	9	3	2	6	5	7	1	4

Date, 1958	Number of hauls	Length in centimetres 24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	>40	Number of fish
October	2	9	7	6	9	4	10	2	2	—	3	2	3	1	—	—	—	—	—	583
November ..	2	3	—	2	1	3	3	1	1	2	2	1	1	1	1	—	—	—	1	211

Measurements were made in the usual way (total length). Six hauls were made in the Godthåb fjord, two in April, one in May, two in July, and one in October; in all, 4,107 redfish were caught.

In the Tunugdliarfik fjord 794 redfish were taken in four trawl hauls, two in October and two in November.

Otoliths were collected for age determination and various meristic observations were made in connexion with racial investigations.

Forty-one redfish were marked in the Godthåb fjord.

P. M. Hansen

Features of the Length Distribution of Redfish off the Labrador Coast

(Figures 2–3)

In July 1958, a cruise was made to the Labrador Sea to search for redfish. Samples were taken from about 45 hauls at different depths and positions on the Hamilton Inlet Bank and the new fishing ground Sundáll, NE of Belle Isle (Fig. 2). In all the hauls made on Hamilton Inlet Bank the redfish catches were composed mainly of the *mentella* type, but in the Sundáll area they were mixed with the *marinus* type. In the following these types have not been separated.

By measuring the redfish it was observed that some few types of length distribution occurred repeatedly at different trawl stations and in different hauls at the same station.

Figure 3A shows a type of length distribution which occurred in at least one of the hauls at all trawl stations on Hamilton Inlet Bank. The length distribution is similar for males and females with a peak at 37 cm. The diagram is computed from the means of four groups of the same type with very slight differences in length distribution.

Figure 3B shows the second type of length distribution which occurred at two stations (T 58—3 and 58—7) in six hauls made at depths of 210—220 fm. Although the length distribution of males is similar to that shown in Figure 3A the length distribution of females has two maxima, at 34—36 cm and at 40—42 cm.

Figure 3C shows a length distribution which occurred in two hauls at the same two stations (T 58—3 and 58—7) and which can be considered a variation of the second type shown in Figure 3B.

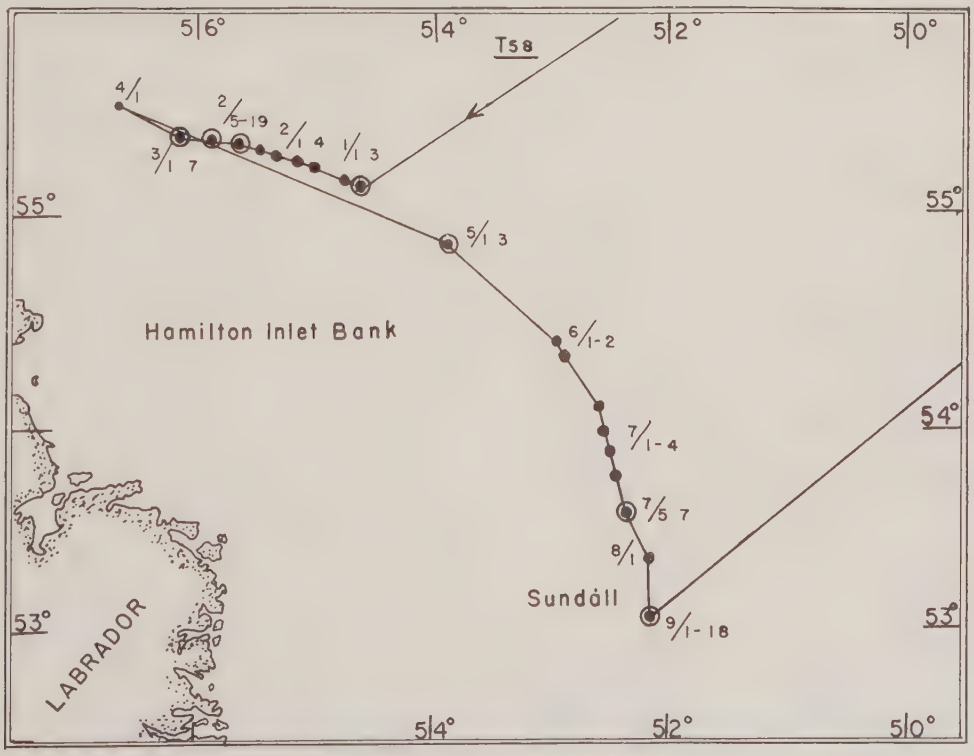


Figure 2. Position of trawling stations.

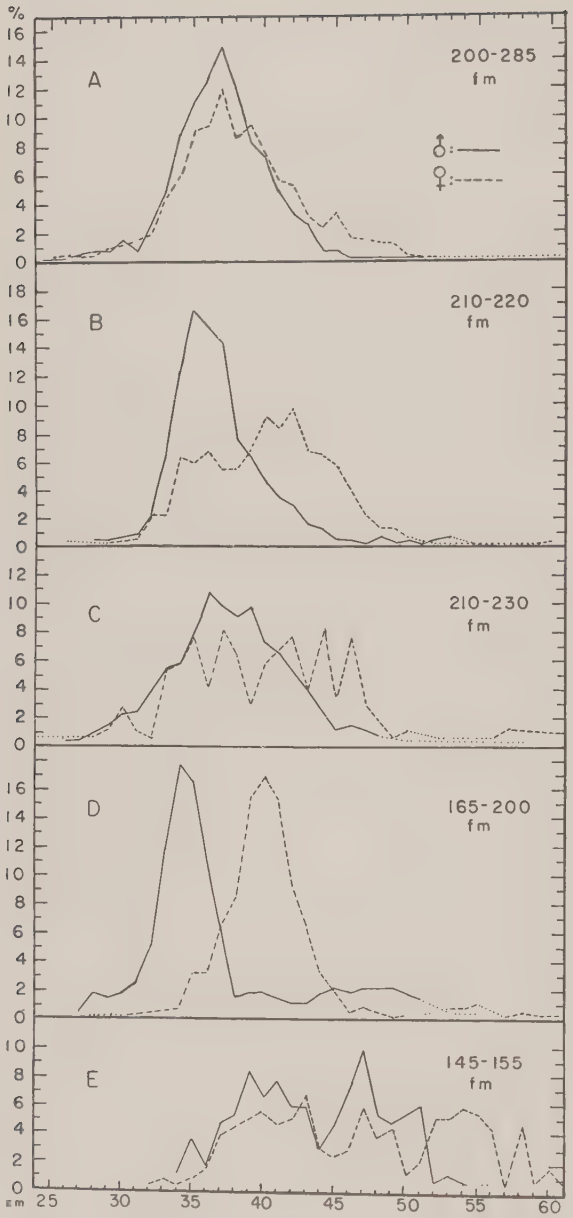


Figure 3. Diagrams showing the various types of length distribution of redfish. Males: unbroken line. Females: stippled line.

In the Sundáll area (T 58—9) the separation of the sexes according to size is even more obvious, as seen in Figure 3D which is based on measurements from 6 hauls made at depths of 164—200 fm. Here the length distribution has two distinct peaks, one for males the other for females.

In other hauls made at the same station at depths of 145—155 fm, the length distribution is quite different compared to the other hauls, as shown in Figure 3 E. It should be noticed that the redfish there consisted mainly of the *marinus* type.

The phenomenon that distinct types of length distribution occur within the same area has previously been observed in other regions. It thus supports the opinion that the redfish present in one area may form distinct shoals which are different from one another as regards size, and, consequently, age.

JAKOB MAGNÚSSON

Rare Fish

A. Records of the Institut für Seefischerei, Hamburg

In 1958, the Government of the Federal Republic of Germany commissioned commercial trawlers to a series of cruises in seach for trawling grounds not yet exploited by the deep-sea fisheries. On board each of the trawlers a biologist collected data for the fishery, as well as for some basic hydrographic conditions, echo-sounder records, etc. During these investigations the Institut für Seefischerei in Hamburg received a rather interesting collection of fishes from distant northern seas. As in 1957, specimens of species are only reported which in some way or other are remarkable for the area, in accordance with the pattern of the corresponding contribution of the previous year. Some species, such as *Benthosema glaciale* (Reinhardt), *Gadus ogac* Richardson, *Myoxocephalus scorpius groenlandicus* (Cuvier & Valenciennes), etc. which have already been mentioned several times, are omitted.

Most of the records are from the waters off East and West Greenland. But there are also records of interesting finds from Jan Mayen and Iceland. The data are those of the actual captures, unless otherwise stated; the length measurements are standard lengths.

Argyropelecus hemigymnus Cocco 1827
17. 9. 1958, 65°04′N, 34°00′W, 300 m, 1, 23 mm, from stomach of *Sebastes*.

Aspidophoroides olrikii Lütken 1876
20. 8. 1958, 68°00′N, 54°32′W, 70 m, 1, 66 mm.

Bathylagus atlanticus Goode & Bean 1878
20. 9. 1958, 65°42′N, 29°20′W, 415 m, 2, 105 and 163 mm, from stomach of *Sebastes*.

Boreogadus saida (Lepechin 1774)
18. 9. 1958, 70°32′N, 08°38′W, 200 m, 1, 241 mm; 21. 9. 1958, 67°10′N, 30°15′W, 190 m, 1, 103 mm.

Brama brama (Bonnaterre 1788)
2. 10. 1958, SW Iceland (Mehlsack), 3, not measured.

Careproctus reinhardti (Krøyer 1862)
17. 9. 1958, 66°15′N, 12°42′W, 220 m, 1, 132 mm;
18. 9. 1958, 70°32′N, 08°38′W, 200 m, 1, 197 mm.

Centrolophus britannicus Günther 1860
3. 10. 1958, 65°27′N, 30°05′W, 420—430 m, 1, 388 mm, first record for Greenland waters.

Ceratias holboelli Krøyer 1844
14. 6. 1958, Faroe-Iceland Ridge (Rosengarten), 450 m, 1♀, 85 cm in total length.

Chauliodus sl. sloanei Schneider 1801
15. 9. 1958, 64°30′–20′N, 35°10′–20′W, 420 m, 1, 151 mm, from stomach of *Sebastes*.

Cryptopsaras couesi Gill 1883[1])
20. 8. 1958, (landed), NW Iceland (Gammelloch), 1♀, 307 mm.

Cyclothone braueri Jespersen & Tåning 1926
15. 9. 1958, 64°30′–20′N, 35°10′–20′W, 420 m, 3, to a great extent digested, from stomach of *Sebastes*.

Eumicrotremus spinosus (Fabricius 1776)
18. 9. 1958, 70°32′N, 08°38′W, 200 m, 1, 44 mm.

Gaidropsarus argentatus (Reinhardt 1838)
17. 9. 1958, 65°04′N, 34°00′W, 300 m, 1, 76 mm, from stomach of *Sebastes*.

Lampadena braueri Zugmayer 1914
20. 9. 1958, 65°30′N, 30°00′W, 410—420 m, 1, 130 mm,
3. 10. 1958, 65°27′N, 30°05′W, 420—430 m, 3, 98, 98, and 157 mm,
all from stomachs of *Gadus callarias*.
4. 10. 1958, 64°26′N, 27°00′W, 450 m, 1, 87 mm, from stomach of *Sebastes*.

Lampanyctus crocodilus (Risso 1810)
15. 9. 1958, 64°30′N, 35°10′W, 420 m, 1, 146 mm, from stomach of *Sebastes*.
20. 9. 1958, 65°30′N, 30°00′W, 410 m, 3, 110, 124 mm, and one without tail,
from stomach of *Gadus callarias*.

Lepidion eques (Günther 1887)
4. 10. 1958, 64°26′N, 27°00′W, 440 m, 1, 226 mm.

[1]) 378 mm in total length. One of the largest specimens found and certainly the largest one without dwarfed male, cf. Shoemaker, Copeia, 1958 (2): 143–44.

Leptagonus decagonus (Bloch & Schneider 1801)
18. 9. 1958, 70°32′N, 08°38′W, 200 m, 1♀, 179 mm.

Lumpenus (*Leptoclinus*) *maculatus* (Fries 1837)
19. 8. 1958, 69°47′N, 55°28′W, 95 m, 1, 102 mm;
18. 9. 1958, 70°32′N, 08°38′W, 200 m, 1, 170 mm.

Lycodes esmarkii Collett 1880
20. 9. 1958, 65°47′N, 29°55′W, 370 m, 1, 485 mm;
30. 9. 1958, NW Iceland (Gammelloch), 1, 512 mm.

Lycodes reticulatus macrocephalus Jensen 1904
20. 9. 1958, 67°00′N, 30°25′W, 420 m, 1, 239 mm;
22. 9. 1958, 67°32′N, 26°00′W, 500 m, 1, 306 mm.

Maurolicus mülleri (Gmelin 1789)
25. 9. 1958, NW Iceland (Gammelloch), 135 m, 2, not measured, from stomach of *Gadus callarias*.

Myctophum (*M.*) *punctatum Rafinesque* 1810
9. 9. 1958, 61°04′N, 41°32′W, 260 m, 2, 78 and 86 mm,
17. 9. 1958, 65°04′N, 34°00′W, 300 m, 1, 79 mm,
17. 9. 1958, 66°15′N, 12°42′W, 220 m, 2, 55 and 78 mm,
26. 9. 1958, 64°44′N, 35°06′W, 500 m, 3, 63, 78, and 83 mm, all from stomach of *Sebastes*.

Nansenia groenlandica (Reinhardt 1839)[2])
15. 8. 1958, 60°47′N, 49°08′W, 215 m, 1, 155 mm, from stomach of *Sebastes*.

Notolepis (*Profundisudis*) *rissoi krøyeri* (Lütken 1892)
4. 10. 1958, 64°26′N, 27°00′W, 450 m, 1, 158 mm, from stomach of *Sebastes*.

Notoscopelus elongatus (Costa 1844)[3])
15. 8. 1958, 60°05′N, 46°12′W, 125 m, 1, 98 mm, from stomach of *Gadus callarias*.
9. 9. 1958, 61°04′N, 41°38′W, 260 m, 3, 95, 107, and 121 mm, from stomach of *Sebastes*.
17. 9. 1958, 65°04′N, 34°00′W, 300 m, 3, 75, 78, and 83 mm, from stomach of *Sebastes*.

Notosudis lepida Krefft & Maul 1955
21. 9. 1958, 67°40′N, 30°20′W, 320—340 m, 1, 217 mm.
Third and northernmost specimen from East Greenland. Probably from stomach of *Gadus callarias*.

[2]) Probably the first record from South Greenland, the type coming from the vicinity of Fiskenæs.

[3]) That species was absent in 1957, as mentioned in the previous record.

Raja fyllae Lütken 1887
28. 8. 1958, 64°02′N, 53°40′W, 310 m, 1♀, 480 mm in total length.
20. 9. 1958, 65°42′N, 29°20′W, 410—420 m, 1♀, 440 mm in total length.

Raja lintea Fries 1839
24. 8. 1958, 63°53′N, 53°26′W, 270 m, 1♂, 2♀♀, 1045, 1170, and 1190 mm in total length.
26. 8. 1958, 63°26′N, 52°45′W, 287 m, 1♀, 1190 mm in total length.

Searsia schnakenbecki Krefft 1953
15. 9. 1958, 64°30′N, 35°10′W, 420 m, 1, 131 mm;
3. 10. 1958, 65°27′N, 30°05′W, 425 m, 5, 92, 102, 108, 110, and 114 mm,
all from stomachs of *Gadus callarias*.

Serrivomer spec.
13. 9. 1958, 64°30′–20′N, 35°10′–20′W, 420 m, 1, 533 mm,
20. 9. 1958, 65°30′N, 30°00′W, 420 m, too badly damaged to be measured and identified with one of the two species known from Denmark Strait. From stomachs of *Gadus callarias*.

Stomias boa ferox Reinhardt 1842
15. 9. 1958, 64°30′N, 35°10′W, 420 m, 7, 103, 112, 112, 115, 165, 165 mm, and one without tail,
17. 9. 1958, 65°04′N, 34°00′W, 300 m, 1, 89 mm,
26. 9. 1958, 64°44′N, 35°06′W, 500 m, 1, 175 mm,
all from stomach of *Sebastes*.

Urophycis blennioides (Brünnich 1768)
1. 10. 1958, 63°16′N, 25°30′W, 330 m, 1, 403 mm.

G. Krefft

B. Records of the Institut für Meeresforschung and the Abteilung Fischereibiologie der Biologischen Anstalt Helgoland, Bremerhaven

The numbers of remarkable fishes delivered by commercial trawlers to our institutes were very small, as in the three previous years. The fishes were identified either by Dr. Brandes (IFM) or Dr. Kotthaus (BAH).

There are no catches made by F.R.S. "Anton Dohrn", that ship being occupied in 1958 mainly with other work, especially in connexion with the IGY programme.

The measurements are given in total lengths, measured to the centimetre below, unless otherwise stated.

Alepisaurus ferox Lowe 1833
30. 1. 1958, Iceland, 1, 143 cm, IFM.

Argyropelecus gigas Norman 1930 (Res.)
28. 3. 1958, SW Iceland (Mehlsack), 1, 8 cm, standard length. First record for Iceland, northern limit of distribution known as abt. 37°N, IFM.

Beryx decadactylus Cuvier & Valenciennes 1829
abt. middle of January, 1958, 64°N, 12°W, 420 m, 1, 56 cm, BAH.

Brama brama (Bonnaterre 1788)
6.—13. 9. 1958, Iceland-Faroe Ridge (Rosengarten), 1, 56 cm, BAH.
3.—13. 10. 1958, 65°10′N, 25°00′W, 2, 54 and 56 cm, BAH.

Centrolophus niger (Gmelin 1788)
1. 9. 1958, Iceland-Faroe Ridge (Rosengarten), 1, 75 cm, IFM.

Linophryne lucifer Collett 1886
16. 6. 1958, Iceland-Faroe Ridge (Rosengarten), 1, 21 cm,
according to Bertelsen, Dana Rep. 39, 1951, only known from the specimen caught off the Azores, IFM.

Mola mola (Linnaeus 1758)
19. 9. 1958, off Faroe Islands, 1, 101 cm, IFM.

Nesiarchus nasutus Johnson 1862
abt. middle of August, 1958, Iceland-Faroe Ridge (Rosengarten), 1, 98 cm, BAH.

Notacanthus phasganorus Goode 1881
23. 8. 1958, Iceland-Faroe Ridge (Rosengarten), 1, 102 cm, IFM.
1. 9. 1958, Rosengarten, 1, 94 cm, IFM.

Scomberesox saurus (Walbaum 1792)
1. 10. 1958, 63°35′N, 12°15′W, 450 m, 1, 35 cm, BAH.

Trachypterus arcticus (Brünnich 1788)
7.—15. 9. 1958, Iceland-Faroe Ridge (Rosengarten), 400—450 m, 1, 137 cm, BAH.

C.-H. Brandes, A. Kotthaus

Scotland

Macrurus fabricii Sundervall—1: Iceland, VIII.

Aphanopus carbo Lowe—2: George Bligh Bank, VII.

Anarhichas latifrons Steenstrup and Hallgrímsson 1: Faroe, V.

B. B. Rae, J. M. Lamont

B. Near Northern Seas

Flatfish in the Skagerak-Kattegat Area

(Tables 3–5)

Coastal investigations on the 0 and I-groups

In the fishery for young flatfish in waters of 1—2 m depth the Johansen young-plaice trawl was fitted with a "tickler" chain in front of the footrope. Already in 1957, fishing was carried out with this new type of gear but the results obtained then did not indicate any significant difference. The figures given in Ann. Biol. XIV were therefore not corrected for the new gear. More comparative hauls were made in 1958 and these clearly revealed that the new type of gear caught about three times as many 0-group plaice than the old one, and about one-third more of group I fish. More comparative work is planned for 1959 but in anticipation the figures for the density presented in Table 3 have been reduced according to the ratios mentioned above, in order to make them comparable to the results obtained in previous years.

In July 1958, 10 hauls were made in the Skagerak but some of these catches have not yet been fully analysed; a very large number of 0-group plaice were, however, found there.

Table 3 shows that the strength of the 1958 year-class in the northern Kattegat was about 50% greater than normal, but it amounted only to one-third of the numbers of the 0-group in 1957. Group I plaice appeared to be very abundant here in both years, viz., four times the normal in 1957, and twice the normal in 1958. On an average the strength of the I-group amounts to half the numbers obtained for the same year-class the previous year. The I-group plaice in 1957 was therefore more plentiful than should have been expected from the strength of the 0-group in 1956, when it was about twice the normal. A more abundant I-group might, however, have been expected in 1958 on account of the very high numbers of 0-group plaice found in 1957. The density of plaice in the northern Kattegat and adjacent areas is no doubt very much influenced by migration, and there is evidence for assuming that great numbers of the I-group plaice encountered in 1957 had immigrated from the Skagerak coast. On the other hand, emigration of young plaice from the northern to the central Kattegat had presumably taken place between the summers of 1957 and 1958, as will be explained below.

In the central Kattegat the strength of the 0-group plaice in 1957 and 1958 was about the same and amounted approximately to half the normal level. On the other hand, I-group plaice was very scarce here in 1957 but the numbers were twice the normal in 1958. The last fact tallies with the assumption of an immigration of young plaice to this region, it must, however, be taken into consideration that a very great portion of the I-group fish is encountered outside the coastal zone because the growth-rate of young plaice is faster here than in the northern Kattegat.

Table 3. Numbers of 0- and I-group plaice caught per hour with the Johansen young-plaice trawl in Danish coastal waters in July/August 1957 and 1958

(Preliminary figures. The means are for the period 1905 to 1958)

	No. of stat.	0-group 1957	0-group 1958	0-group Mean	I-group 1957	I-group 1958	I-group Mean
N. Kattegat	18	400	148	97	200	118	55
C. Kattegat	16	16	18	37	1	26	12
S. Kattegat	15	60	63	20	0.2	20	2

In the southern Kattegat the numbers of 0-group plaice were about three times larger than normal both in 1957 and 1958, and furthermore were the numbers of I-group fish larger in 1958 than might have been expected from the strength of the 0-group in 1957. Also here immigration from more northern shores seems to have taken place, but other factors may also have been of influence.

By courtesy of the Swedish government coastal investigations with the "Havkatten" were allowed in Laholm Bay and Skelderviken. Fishing at 19 stations in August revealed that the density of 0-group plaice was larger here than on the Danish coasts of the southern Kattegat; analyses of the catches from two or three very rich stations have not yet been carried out.

0-group *flounder* occurred in quantities over normal north and east of Djursland, at North Seeland, and in the Laholm Bay. The average catch of I-group flounders was large, especially at Djursland.

An unusually large number of 0-group *brill* occurred in the Kattegat and a fairly large number of I-group fish was also encountered there. North of Seeland some 0-group *turbot* were caught; 0-group *sole* were present, especially in the southern Kattegat, and in extraordinarily large numbers in Laholm Bay and Skelderviken.

The stock of plaice in the Kattegat at more than 5 metres depth

In the western part of the northernmost Kattegat investigations of the stock of plaice were undertaken with the standard trawl in June and November, as usual. Length and age distributions are

Table 4. Length and age distributions of plaice in the northern Kattegat and off Mariager fjord (central Kattegat) in 1958
(Preliminary figures. Length measurements to the nearest lower whole centimetre)

	Depth, m	No. of hauls	Age-groups 0	I	II	III	IV	Length groups in cm <10	11–15	16–20	21–25	26–30	31–35	36–40	Total
Northern Kattegat, standard trawl, number per hour															
June	6–14	5	—	1	13	3	0.4	1	0.4	7	7	2	0.4	—	18
	15–24	3	—	2	1	3	—	1	0.6	0.6	1	2	0.6	—	6
	25–34	4	—	2	0.5	—	—	—	2	—	0.5	—	—	—	3
	35–60	7	—	7	1	1	—	0.6	5	1	0.6	0.3	0.3	—	8
November	6–14	2	8	29	16	—	—	8	2	14	16	10	3	—	53
	15–24	3	0.7	7	4	—	—	0.7	—	2	5	3	0.7	0.7	12
	25–34	3	—	69	6	0.7	—	—	14	49	11	1	0.7	—	75
	35–60	3	—	22	0.7	2	—	—	5	13	4	2	—	0.7	25
Northern Kattegat, off Saeby, about 1. September (%)															
Danish seine ...	7–12	3	7	80	13	0.1	—	7	16	61	11	5	0.2	—	100
	17	8	0.2	79	21	0.1	—	0.2	15	60	15	9	0.4	0.01	100
Trawl	14	6	12	81	7	0.1	—	12	23	57	5	2	0.1	—	99
	17	3	4	89	7	—	—	4	27	63	5	2	0.1	—	101
Central Kattegat, off Mariager fjord, standard trawl (%)															
9. July	8	1	—	—	—	—			16	76	8	—	—	—	100
18. November ..	14	1	—	10	84	6	—	—	—	29	65	6	—	—	100

given in Table 4; it appears that the density of the stock, especially the I-group (1957 year-class) increased between the months of observation. Age-groups I-IV had fallen very much off during the summer of 1957, mainly on account of emigration, but between November 1957 and June 1958 the depletion was somewhat less than might have been expected from the effect of fishery and natural mortality.

The increase of the stock between June and November 1958 must be mainly due to immigration from the central Kattegat. In 1957, large numbers of 0-group plaice occurred in the coastal region at 1—2 m depth. In June 1958 the I-group was relatively scarce here. In the central Kattegat an intensive fishery for plaice just over the Danish size limit (26 cm) had been carried out since September, but the fishermen had encountered very many undersized fish, and this had also been the case in the preceding months. The fishery improved, however; at first in the westernmost parts of the area, but in September the stock of larger fish had been displaced to the east and north-east. Experimental hauls made off Mariager fjord in June, and between Læsø and Jutland in August showed that the many undersized fish were one year-old plaice (1957 year-class). In late summer a number of these fish had surpassed the size limit, but the bulk of the commercial size plaice belonged to the II-group. This was observed between Læsø and Jutland, near the southern limit of the northern Kattegat, on 1. September when the stock was investigated with the "Jens Væver" in connexion with comparative fishing experiments carried out with Danish seine and trawl, both with a fine mesh cover. The percentage age and length distributions are given in Table 4 and it is seen that they were similar to the distributions found in the northern Kattegat in November, especially for the trawl catches. The Danish seine caught relatively more large plaice than the trawl. Since the two gears were used in nearly the same places, the distribution in the trawl catches should be compared with the distribution found in the northern Kattegat.

The plaice investigated at the southern entrance to the northern Kattegat belong to the North Sea race with a mean number of ventral fin rays of 54.2 (75 fish), the same figure as found for the northernmost Kattegat, viz., 54.4 in 36 plaice of groups I–V examined in April—November. In the more southerly sections of the central Kattegat the plaice appeared to be mixed with Belt Sea plaice during the summer. In July the age and length distributions off Mariager fjord were as shown in Table 4. It is seen that the length of the fish was similar to that observed between Læsø and Jutland about 1. September. The length distribution reveals that almost all of these plaice were I-group fish, but, according to Bagge the mean number of ventral fin rays was 52.7 (111 fish) which clearly shows that most of them belonged to the Baltic race. When the "Biologen" fished again in the same locality in November the stock had completely changed. The length had increased from 18.1 to 27.8 cm, viz., about 10 cm, a fact which of course cannot be ascribed to four months' growth. The number of ventral fin rays (54.1, 49 fish) revealed that the stock now consisted of the North Sea race. In 1956, the

Table 5. Length distribution (%) and average length of plaice in Danish commercial catches from the Skagerak and Kattegat in 1958

(Length measurements to nearest lower whole centimetre. Averages corrected)

	Depth, m	Number of hauls	Length, cm 26—27	28—30	31—35	36—40	41—45	46—50	Mean
Skagerak, N of the Scaw									
1957, April—May	9—17	4	57	21	9	2	—	—	28.5
1958, April	14	1	41	37	22	—	—	—	29.1
1958, April	26	1	—	10	46	24	20	—	35.8
1957, May	49	1	2	18	63	10	6	—	33.4
1958, April	42	1	16	33	39	8	4	—	31.7
1958, April	56	1	—	23	49	18	8	3	34.5
1957, November	13—21	2	10	24	47	17	2	—	32.8
1958, November	23—43	2	13	11	43	25	8	—	34.4
Some 20 miles ESE of Hals									
1957, July	12—15	4	5	20	55	18	2	—	33.3
1957, August	13—15	2	13	33	49	4	—	—	31.3
1958, August	10	2	42	34	22	1	—	—	29.2
1958, August	13	1	5	15	69	8	3	—	33.3
1958, September	11—14	4	67	33	2	0.6	—	—	27.8
1958, October	12	2	12	48	38	3	0.2	—	30.6
Some 15 miles E and S of Grenaa									
1957, December									
1958, January	22—28	4	4	20	40	31	6	--	35.1
1958, December	24—30	2	10	20	45	18	7	--	33.3
Some 15 miles E and SE of Grenaa									
1957, August	25	1	14	33	45	8	—	—	31.6
1958, August	19	1	14	36	40	9	—	—	31.5
1957, October—November	21—26	4	8	24	48	15	5	1	33.2
1958, September—November	19—25	3	8	19	51	21	2	—	33.3
1957, December									
1958, January	19—28	5	4	18	40	30	6	—	35.2
1958, December	18—30	3	8	21	39	20	12	1	34.0

0-group was more plentiful than usual in the coastal waters of the northern Kattegat, it was, however, below normal in the central and southern Kattegat. In the northern Kattegat a dense stock of this brood was also observed in 1957, even denser than might have been expected from the number of 0-group plaice found there in 1956. In June 1957 they were encountered in relatively large numbers also outside the 6 m depth line, but in November 1957 they had disappeared, presumably because many had migrated southwards to the coastal area of the central Kattegat, but in the late summer of 1958 they migrated northwards again. In the northern Kattegat the abundance of the 1957 year-class was about four times the normal level, but in the central Kattegat it was about normal. However, before the summer of the following year this year-class appeared to be very much reduced in the northern Kattegat; it must be assumed that a large number had migrated southwards. From the investigations of the commercial catches, discussed below, it appears that no large-scale immigration of young plaice from the Skagerak to the northern Kattegat may have taken place in 1958.

In the southern Kattegat, at 20—28 m depth, 7 hauls were made in June with the "Biologen"; on an average only 0.7 plaice were caught per hour. In July/August 10 hauls were made at 18—28 m depth; these hauls yielded a mean of two plaice per hour, about 35 cm long and belonging to the 1955 year-class. In the southern Kattegat and in the northern Belt Sea this year-class was the strongest observed in recent years, but since it had now almost disappeared from the stock, the fishing was poor.

Commercial catches of plaice in the Skagerak and Kattegat

On the Skagerak coast north of the Scaw the length of the plaice caught varied very much from place to place, rather independent of depth. As a whole the mean length was a little higher than in 1957, both in spring and in November.

In the central Kattegat outside the coastal zone the mean length and length distribution of the plaice caught in July/August 1957 and in August 1958 were more or less the same. From place to place there were slight differences, and in August 1958 plaice just over the size limit for commercial

fish (26 cm) were abundant in some catches, whereas larger plaice dominated in other catches. In September 1958, predominance of very small fish was observed in all samples analysed, but in October the smallest specimens, under 28 cm were relatively scarce, whereas those of about 30 cm predominated in the catches. According to their length most of these plaice in the central Kattegat must belong to the II-group (1956 year-class) which in August had a mean length of about 27 cm, but the fastest growers of the rich 1957 year-class, reaching a mean length of about 17 cm in August, must also in gradually increasing proportions have participated in the commercial catches in the autumn. The occurrence of large numbers of undersized and small commercial fish and their migrations in the autumn of 1958, has been discussed above.

It can be derived from Table 5 that plaice just over the size limit were abundant in a catch taken on the coast north of the Scaw in April, but that they were scarce again in other hauls and in catches taken in deeper water; in November they were also scarce in this region. It seems therefore most likely that the northern Kattegat has received all, or almost all, of the small fish migrating from the central Kattegat.

Aa. J. C. Jensen

Dogfish

Norwegian Dogfish Tagging

(Figure 4)

In November 1958, a tagging experiment on the spiny dogfish (*Squalus acanthias*) was carried out from a commercial long-liner. The tag used was a yellow slip of polyethylene film with printed text, rolled up as a cylinder. It was fastened to the fish by means of a stainless bridle, about two inches in front of the first dorsal fin. In all, 1,000 tagged fish were released, as shown in the table below.

Up to 1. February 1959 there are 12 recaptures. In Figure 4 the data on the migrations are presented.

Olav Aasen

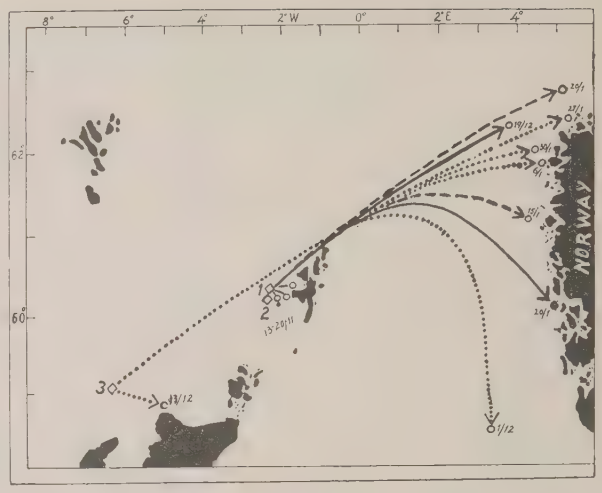


Figure 4. Migrations of tagged spiny dogfish, November 1958/January 1959.
Nos. 1, 2, and 3 = tagging localities.
Continuous line = migrations from 1.
Broken line = migrations from 2.
Dotted line = migrations from 3.

Eel

Eel Tagging and Recapture in the North Sea

The Institute of Coastal and Freshwater Fisheries is conducting investigations relative to the fishery conditions in the river Elbe. In this connexion, fishes belonging to different species have been tagged in order to study their migrations and the exchange of fish stocks. Hence, 1,717 eels were tagged during the spring and summer of 1957. The eels were released after tagging, mostly in the upstream section of the river Elbe between Hamburg and Lauenburg, and a few in the harbour area of Hamburg. Of these tagged eels, 151 specimens, or 8.8%, were recaptured at the end of 1957. Of the total number of tagged eels 461 specimens, or 26.9%, were silver eels. Ninety of these were recaptured, that is, 59.6% of the total number of recaptured eels. From these figures it follows that the recapture percentage of silver eels was 19.5%, or four times higher than that of the younger fish.

In the autumn of 1958, a further 281 eels were tagged and released in the river Elbe, this time

Dogfish tagging

Tagging locality	Date, November 1958	Number tagged	Numbered	Recaptures per 1. February 1959
1. 60°20′N, 02°15′W	10.—11.	400	H 1—H 400	5
2. 60°13′N, 02°15′W	11.	200	H 400—H 600	2
3. 59°03′N, 06°21′W	12.—13.	400	H 601—H 1000	5

near Schnakenburg (150 km upstream of Hamburg); 258 of these fish were silver eels. Out of the 281 eels, 76 specimens, or 27.1%, were recaptured. For the silver eels only, the recapture percentage amounts to 36%.

Of special interest is the result obtained with two silver eels recaptured far outside the area of investigation. Both eels were tagged and released in the autumn, near Gorleben (130 km upstream of Hamburg). One of these was recaptured three weeks after being released, near Hvide Sande, Ringkøbing fjord, Denmark, about 1,000 metres off shore. The other eel was caught six weeks later, near Svanholmsløb in the Limfjord. These results suggest that, on their way to the Atlantic, the Elbe eels do not migrate through the southern North Sea and the English Channel, but most likely along the Danish coast and around Scotland. This assumption is supported by the fact that the coastal current in the German Bight is generally flowing towards north-west, in a counter-clockwise manner. It is probable that the migrating silver eels follow this residual current of the tidal system.

H. Mann

Reference

Lühmann, M., & Mann, H., 1958. "Wiederfänge markierter Elbaale vor der Küste Dänemarks". Arch. Fischereiwiss., **9** (3).

Sand-eel

The German Fishery for Sand-eel in 1958

In 1958, the German sand-eel fishery commenced in April and terminated in August, whereas in 1957 it was carried out from March to July. The total landings of 669 fishing trips amounted to 20,179 tons in 1958 as compared with 794 trips and 25,535 tons in 1957. The catches were landed as follows:–

	Tons
Cuxhaven	12,599
Bremerhaven	6,707
Hamburg-Altona	531
Büsum	342
Total	20,179 tons

The monthly distribution of the total catches was as follows:—

	%
April	0.8
May	19.9
June	57.0
July	22.0
August	0.3

At the termination of the sand-eel fishery, the participating fishing boats continued their operations in the "oil" herring fishery.

Eleven random samples comprising 4,500 specimens were measured from May to July. The average length of the sand-eels was 13.0 cm in May, 16.8 cm in June, and 18.7 cm in July. The fat content of the sand-eels was lower than in 1957. A similar observation was made on herring during the spring and summer of 1958.

The catches consisted almost exclusively of *Ammodytes lancea marinus*. The coastal subspecies, *A. lancea lancea*, which is frequently present in the shrimp catches, and also the large sand-eel, *A. lanceolatus*, were practically absent in the catches of the industrial sand-eel fishery.

The fishing grounds were the same as in 1957, i.e., from Terschellinger Bank to Borkum Riff.

Egg counts were made in both subspecies of the small sand-eel.

P. F. Meyer-Waarden

Reference

Kühl, H., & Lühmann, M. "Untersuchungen über den Sandspierling und die Sandspierlingsfischerei". Arch. Fischereiwiss. (in press).

Rare Fishes

Germany

The following rare fishes were landed in Germany from the North Sea and western grounds in 1958. The identifications were made by Dr. C.-H. Brandes, Institut für Meeresforschung, Bremerhaven (IFM), and by Dr. G. Krefft, Institut für Seefischerei, Hamburg (IS).

Scyliorhinus canicula (Linnaeus 1758)
1♂; 825 mm in total length : Northern Viking Bank, abt. 61°N, IV (IS).

Somniosus microcephalus (Bloch & Schneider 1801)
1♀; abt. 4 m : North-eastern North Sea, abt. 60°30′—61°10′N, II (IS).

Torpedo nobiliana Bonaparte 1835
1; 85 cm : 58°—59°N, 7°—8°W, XI (IFM).

Lampris guttatus (Brünnich 1788)
1; 113 cm : 58°—59°N, 6°—7°W, VIII (IFM).

Pagellus centrodontus (Delaroche 1809)
1; 46 cm : Bressay Shoal, VIII (IFM).

Trachypterus arcticus (Brünnich 1788)
1; 181 cm : 58°35′N, 2°30—35′E, XI (IFM).

G. Krefft

Scotland

The following rare fishes were recorded in Scotland in 1958:—

Oxynotus paradoxus Frade—1: Scottish west coast.

Scymnorhinus licha (Bonnaterre)—1: Shetland, VIII.

Squatina squatina (L.)—1: Solan Bank, V.

Torpedo nobiliana Bonaparte—2: Moray Firth, XI, XII.

Myliobatis aquila (L.)—1: East of Firth of Forth, XI.

Acipenser sturio (L.)—4: Minch, XII; Moray Firth, XII; Aberdeenshire coast, VIII; East of Firth of Forth, I.

Alosa alosa (L.)—2: Firth of Clyde, III; Minch, VII.

Alosa finta (Cuvier)—3: Moray Firth, II, III; Aberdeenshire coast, I.

Engraulis encrasicholus (L.)—2: Moray Firth, XI.

Bathylagus sp. Günther—1: NW Ireland, X.

Scomberesox saurus (Walbaum)—Several: Orkney, I (1); Shetland, II (1), VII (1), IX (1), XII (10); North coast, VIII (1), X (1); Moray Firth, XII (2); Cromarty Firth, XII (shoal).

Belone belone (L.)—Several: Northern North Sea, V, IX, XI (5); Aberdeenshire coast, VI (several), X (1).

Coelorhynchus coelorhynchus Gunner—4: Shetland, XII.

Malacocephalus laevis (Lowe)—4: Shetland, I (2); St. Kilda, IX; 58°10′N, 9°28′W, IX.

Trachypterus arcticus (Brünnich)—2: St. Kilda, VII; NW Ireland, X (post larval stage).

Brama raii (Bloch)—6: Porcupine Bank, X (2); Minch, XII; Rockall, VIII; Mar Bank, XI; Moray Firth, X.

Mullus surmuletus (L.)—5: Shetland, VII; 60′E x N Buchan Ness, II; Minch, IX; not known, II (2).

Spondyliosoma cantharus (Gmelin)—4: Shetland, II; Moray Firth, I; East of Moray Firth, I, II.

Cepola rubescens (L.)—6: Firth of Clyde, XII.

Crenilabrus melops (L.)—4: Firth of Forth, X; Firth of Clyde, V (2); Loch Sween, Argyllshire, V.

Ctenolabrus rupestris (L.)—1: Firth of Clyde, V.

Anarhichas latifrons Steenstrup & Hallgrimsson—2: Moray Firth, V; Viking Bank, VI.

Fierasfer dentatus Cuvier—4: NE Shetland, XI.

Centrolophus niger (Gmelin)—1: 100′E from Aberdeen, II.

Mugil auratus Risso—1: Firth of Forth, VII.

Balistes capriscus (Gmelin)—1: Machrihanish beach, Kintyre, XI (first specimen since 1827).

B. B. Rae, J. M. Lamont

C. Baltic-Belt Seas

Eggs and Larvae of Various Species

(Table 6)

In the 1958 spawning season, the average number of eggs per m² near the "Fehmarnbelt" lightvessel were as given in Table 6.

The spawning of the *cod* was very retarded by low water temperature and low salinity in the first months of the year. Even in April, cod eggs were scarce, and only in May they became more frequent. But in total, the number of cod eggs in the Fehmarnbelt was very low, only two-thirds of that in the previous year which was the lowest ever observed since the beginning of this survey in 1934. Investigations in the Kiel Bay confirmed the poor spawning of the cod in the western Baltic in 1958 caused by unfavourable hydrographic conditions. The spawning of *plaice* was also retarded, and extended to June, the number of plaice eggs was small, as usual. The eggs of the *flounder* were more frequent in April, and those of the *dab* occurred from May to the beginning of August, both species amounting to one-half of the average of 1934—43. As in the previous year, the spawning of the *sprat* was negligible, not only in the Fehmarnbelt, but all over the Kiel Bay where only very few eggs per m² were found. This result tallies with the scarcity of adult sprat in these waters. *Mackerel* eggs were relatively frequent, giving an average of 16 per m² from the middle of June to the middle of July. However, no mackerel larvae at all were found in the western Baltic which fact gives evidence for concluding that the eggs of this species do not develop in this area, owing to the low salinity.

R. Kändler

Flatfish

The Numbers of 0- and I-Group Fish in Coastal Waters

(Table 7)

The Johansen young-plaice trawl used in the fishery for young plaice on the coasts at 1—2 m depth was this year fitted with an iron chain in front of the footrope, as it was in 1957. The comparative hauls made in order to determine how much the iron chain increases the catch are as yet too few, they indicate, however, that the new gear takes three times as many 0-group *plaice* and one-third more I-group fish. The figures in Table 7 are reduced according to these ratios in order to be comparable to the results obtained in previous years. The corresponding figures for 1957 (Ann. Biol., XIV) were not reduced because the few comparisons of the gears made that year seemed to show that no very great increase in the catches was obtained by using the iron chain, and accordingly,

Table 6.

		Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Cod	1958	—	—	1	3	3	17	—	—	—
	1934—43	4	15	81	49	24	3	1	—	—
Plaice	1958	—	—	0.5	1	1.5	0.5	1	—	—
	1934—43	0.5	0.5	2	1	1	—	—	—	—
Flounder and Dab	1958	—	—	—	3	16	24	6	8	3
	1934—43	—	—	8	23	35	35	18	3	—
Sprat	1958	—	—	—	—	—	4	2	2	2
	1934—43	—	—	—	—	—	22	60	60	5
Mackerel	1958	—	—	—	—	—	—	5	11	1
	1934—43	—	—	—	—	—	—	1.5	0.2	—

Table 7. Numbers of 0- and I-group plaice and of 0-group flounder and turbot caught per hour with the Johansen young-plaice trawl and, at Bornholm, also with the hand push-net (h.p.) in July/August 1958

( ) = averages for a series of years

Locality	Number of stations	Plaice 0-group	Plaice I-group	Flounder 0-group	Turbot 0-group
Belts	55	54 (28)	15 (3)	9	0.2
Sound	9	36 (17)	7 (2)	4	0.2
Western part of Baltic proper	14	5 (7)	45	34	0.2
Bornholm	3	4	9	24	6
Bornholm (h.p.)	15	3 (17)	2	139 (231)	26 (25)

they are too high in relation to figures for all other years.

From Table 7 it is seen that the strength of the 1958 year-class was about double the normal in the Belts and the Sound but in the Baltic proper, i.e., on the Baltic coasts of Seeland and Møen (in the table called western part) and at Bornholm it was below normal.

I-group fish occurred in relatively great quantities in all the areas investigated, corresponding to the fact that the 1957 year-class was stronger than normal in each of these areas.

The numbers of 0-group *flounder* encountered on the coasts of the Belts seem to have been about normal. Of *turbot* very small numbers were present, except at Bornholm where the frequency of the 1958 year-class was about normal.

In the southern parts of the Kattegat 0-group *brill* were unusually plentiful, and in the northern Belt Sea their numbers were appreciable. There were relatively large numbers of 0-group *sole* in the Sound and on the Baltic coast of Seeland, and in Laholm Bay and Skelderviken they were also fairly plentiful, but relatively few numbers occurred in the other regions of the Kattegat.

The Stock of Plaice in the Open Sea

(Table 8)

The number of plaice fished per hour by the "Biologen" is shown in Table 8. The stock in the Belts was on the whole more sparse than in 1957. The plaice of the strong 1955 year-class dominated the stock in 1957, but in 1958, as III-group fish, it had fallen very much off and the 1956 and 1957 year-classes were predominant. In the coastal investigations the 1956 year-class had been relatively poor as 0-group fish, but the 1957 year-class had been relatively strong, which corresponds to their frequencies outside the 6 m line in 1958. In the western Baltic the density of the stock was about the same as in 1957. In the Sound one haul at 22 m depth yielded a very great number of plaice, but this haul is of course not representative of the depth

Table 8. Danish catches of plaice taken per hour with the standard trawl, 1958

(Preliminary figures. Length measurements to the nearest lower whole cm)

	Depth, m	Number of stations	Age-groups 0	I	II	III	IV	V	VI	VII	VIII	IX+	Total
Belts													
June—Dec.	5—14	24	—	9	10	4	0.5	—	—	—	—	—	23
	15—24	40	0.1	8	7	5	0.8	0.1	—	—	—	—	21
	>24	39	—	2	2	3	0.5	0.3	0.1	—	—	—	8
W. Baltic													
Aug.—Dec.	5—14	4	—	2	0.5	—	—	—	—	—	—	—	3
	15—24	5	—	1	2	1	0.4	—	—	—	—	—	5
	>24	16	—	0.6	3	2	0.7	0.2	—	—	—	—	6
Sound													
June—Oct.	15—24	1	—	—	—	14	28	6	8	26	6	10	98
	>24	20	—	—	4	2	0.4	0.7	0.2	—	—	—	7
At Møen													
Aug.—Sept.	15—24	2	—	1	3	2	—	—	—	—	—	—	6
	>24	2	—	—	—	11	2	—	—	2	—	—	15
At Bornholm													
Aug.—Sept.	37—73	11	—	—	3	2	0.4	—	—	—	—	—	6

			Centimetre groups 6–11	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	Total
Belts													
June—Dec.	5—14	24	—	3	9	8	3	0.2	0.1	—	—	—	23
	15—24	40	0.1	1	6	8	4	2	0.2	0.1	—	—	21
	>24	39	—	0.1	0.4	2	3	2	0.3	0.1	—	—	8
W. Baltic													
Aug.—Dec.	5—14	4	—	—	—	2	1	—	—	—	—	—	3
	15—24	5	—	—	—	1	2	1	1	—	—	—	5
	>24	16	—	—	—	2	2	2	0.6	—	—	—	6
Sound													
June—Oct.	20—24	1	—	—	—	2	16	28	12	18	14	8	98
	>24	20	—	—	—	—	2	2	2	0.6	0.4	0.2	7
At Møen													
Aug.—Sept.	15—24	2	—	—	—	1	3	1	1	—	—	—	6
	>24	2	—	—	—	—	4	8	—	1	2	—	15
At Bornholm													
Aug.—Sept.	37—73	11	—	—	—	0.2	2	3	0.3	0.2	—	—	6

zone. The abundance of plaice outside the 25 m contour seemed to be less than in 1957. In that year, the II- and III-groups were the most plentiful and, correspondingly, the III- and IV-groups seem to have been plentiful in 1958 also. Characteristic of the plaice in the Sound is their large size and high age, a result of the prohibition for trawling and seining there. On account of the stony bottom at depths shallower than 20 m, we have no knowledge of the stock present there.

At Møen only 4 hauls were made. Group III, the 1955 year-class, seemed to be the most abundant one. At Bornholm the II- and III-groups predominated in the stock outside a depth of about 35 metres.

Danish Commercial Catches of Plaice

(Table 9)

In December a commercial catch from the northern Belt Sea, south of Hasenøre, was measured. In Table 9 the length distribution is compared with that of a catch taken in the same locality in January 1958.

Table 9. Length distribution (%) of plaice taken south of Hasenøre at 20—22 m depth

(Length to nearest cm below. Mean lengths corrected)

cm	January 1958	December 1958
26—27	20	12
28—30	29	21
31—35	28	43
36—40	13	19
41—45	10	5
Mean, cm	32.8	33.2

It is seen that the mean length had not changed in comparison to the length measured 12 months before, as was also the case in the southern Kattegat (see p. 75), but the length composition had changed. In December 1958 a relatively lesser proportion than at the beginning of the year was just over the size limit; the reason being that the stock of commercial plaice in 1957 was recruited from the strong 1955 year-class, in 1958, however, it was recruited from the poor 1956 year-class.

Aage J. C. Jensen

Standard Trawl Catches of Flatfish in the Western Baltic

(Table 10)

Trawling experiments were continued with the R/V "Hermann Wattenberg" (formerly "Südfall") on various fishing grounds in Kiel Bay and the waters around Fehmarn during January, March, July, and October 1958. Length and age distributions of plaice, flounder, and dab resulting from 24 trawling hours at 24 stations are shown in Table 10.

Plaice

The catches were just as poor as in the preceding years (3.8 fish per hour in April/June 1957; 2.1 and 7.3 respectively, in May/June and October 1956). Plaice of the I-group were scarce, indicating only a slight recruitment by the 1956 and 1957 year-classes.

Flounder

The 1955 year-class predominated in the catches at 84%. As the smaller flounders remain in shallow

Table 10. Length and age distributions of plaice, flounder, and dab in hauls made with the standard trawl in the western Baltic

Date, 1958	Number of stations	Total no. of fish caught	Number per hour's fishing: 5 cm group 6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	Age-group I	II	III	IV+	Total
		Plaice													
Jan., 17.	3	22	—	—	—	1.0	1.3	1.0	2.0	0.3	—	2.5	2.3	0.8	5.6
March, 26.–27.	3	20	—	—	0.6	1.2	0.4	0.8	0.4	0.6	0.4	2.2	1.0	0.4	4.0
July, 1.–3.	11	16	—	0.3	0.1	0.5	0.5	0.2	—	—	0.4	0.8	0.4	—	1.6
Oct., 27.–31.	7	15	—	—	0.6	0.6	0.6	1.0	0.2	—	0.6	1.2	1.2	—	3.0
		Flounder													
Jan., 17.	3	19	—	—	—	1.0	1.7	1.3	0.5	0.3	—	3.0	1.0	0.8	4.8
March, 26.–27.	3	73	—	—	0.6	8.2	3.4	2.2	0.2	—	0.4	13.4	0.8	—	14.6
July, 1.–3.	11	24	—	—	—	0.9	1.2	0.3	—	—	—	0.5	1.8	0.1	2.4
Oct., 27.–31.	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Dab													
Jan., 17.	3	22	—	2.0	1.5	1.5	0.5	—	—	—	3.3	1.2	1.0	—	5.5
March, 26.–27.	3	28	0.4	1.6	1.4	1.4	0.6	0.2	—	—	1.8	2.6	1.2	—	5.6
July, 1.–3.	11	223	0.3	3.2	9.1	4.4	4.2	1.0	0.1	—	0.1	11.1	7.0	4.1	22.3
Oct., 27.–31.	7	404	0.6	19.2	26.8	26.0	6.8	1.4	—	—	21	44	12	4	81

water near the coast the numbers of I- and II-group fish were very low.

Dab

The catches of dabs in spring and early summer have decreased continuously during the last three years, from 91 fish per hour in May/June 1956 to 39 fish in April/June 1957, and further to 22 fish in July 1958. In contrast to this, fishing in October 1958 gave the same results as two years ago, viz., 81 and 63 fish respectively, per hour. The II- and III-groups provide the greater part of the catch, as the majority of the I-group fish is too small and escapes the trawl until autumn. The recruitment to the stock seems to have been fairly good in the spawning seasons of 1954, 1956, and 1957, but poor in 1955.

Long rough dab

In October 1958, 38 *Drepanopsetta platessoides* were caught in experimental hauls in the central Kiel Bay and the Fehmarnbelt. The fish were 8—30 cm in length and belonged to age-groups I—III. Obviously young stages of this species have entered the Baltic fairly regularly in the last four years, carried by the bottom current. After growing up they emigrate to the Kattegat for spawning, as eggs never have been observed in the western Baltic.

R. Kändler

Dab

The Stock of Dabs in the Open Sea

(Tables 11–12)

The average number of dabs taken per hour in 98.3 hours trawling and the length distribution of these fish are shown in Table 11. The greatest number per hour's fishing of dabs larger than 28 cm are taken in the Sound and the western Baltic during spring, summer, and autumn. In the northern parts of the Belt Sea large quantities of small dabs less than 16 cm were caught during summer and, especially, in the autumn.

Table 11.

	Number per 1 hour's fishing					Trawling hours	Number of stations
Spring	<16 cm	16—19 cm	20—23 cm	24—27 cm	28 cm		
N. Belts	1.2	7.0	6.8	2.8	0.2	5.3	10
S. Belts	3.0	3.4	2.0	1.0	—	5.0	8
W. Baltic	1.1	3.1	2.5	1.6	2.6	5.0	9
Sound	3.3	10.1	28.6	42.6	4.0	1.5	3
Møen region	—	—	—	—	—	—	—
At Bornholm	—	—	—	—	—	—	—
Summer							
N. Belts	90.5	76.4	41.5	8.8	0.6	13.0	26
S. Belts	13.0	20.3	15.9	8.0	1.2	13.5	27
W. Baltic	6.8	13.6	7.1	4.6	2.1	7.0	14
Sound	21.4	16.9	12.7	15.1	3.8	5.5	11
Møen region	—	—	—	—	—	—	—
At Bornholm	—	—	—	—	—	—	—
Autumn							
N. Belts	226.5	138.5	42.2	9.3	0.3	6.0	12
S. Belts	7.2	16.7	18.3	4.7	0.3	17.0	34
W. Baltic	17.3	26.5	32.0	8.7	3.4	9.0	18
Sound	12.8	23.3	24.8	18.8	3.5	4.0	8
Møen region	—	—	—	—	—	—	—
At Bornholm	0.0	0.0	0.0	0.0	0.0	6.5	13

Table 12.

	Number of stations	Trawling hours	Total catch per 1 hour's fishing 1958	1957	1956	1955
N. Belts	48	24.3	223	253	460	787
S. Belts	69	35.5	48	41	81	586
W. Baltic	41	21.0	57	50	27	82
Sound	22	11.0	78	117	137	71
Møen region	—	—	—	6	36	12
At Bornholm	13	6.5	0	0.5	0.9	1.7

The total number of dabs caught per hour in the northern and southern parts of the Belt Sea, in the western Baltic, and in the area around Bornholm is almost the same as in 1957. In the Sound the numbers have decreased (Table 12).

Ole Bagge

Eel

Forecasts of the yield of the silver-eel fishery in the Belts and the Baltic (together with the Limfjord) were given on the basis of the summer temperature. This was low in the first summer months but later on it rose to above normal, and a normal catch was therefore predicted. Actually the yield was 5% below normal in the Belts, which might be ascribed to very light winds during the period of moon darkness.

The tumour disease of the eels was encountered in fresh water in some localities, especially in eastern Jutland, but it is not certain if the sick eels have immigrated from the sea after being attacked by the disease.

Aage J. C. Jensen

Gadoid Fish

YOUNG STAGES

Greenland

Cod Fry and Small Cod in Coastal Waters and on the Offshore Banks of West Greenland, 1958

(Figures 1–3; Tables 1–2)

Occurrence of cod eggs

The numbers of cod eggs caught with 1 m stramin and 1 m nylon nets in half-hour hauls in the Godthåb fjord area are given in Table 1. The position of the stations is shown in Figure 1. It is seen that large numbers of cod eggs were taken in the spawning area proper (Stations 3, 4, 5) during March and April. The numbers were larger than in any previous year; at the other stations, however, much smaller numbers were obtained than previously.

Occurrence of cod larvae

The number of cod larvae taken with 1 m stramin (and nylon) nets in the Godthåb fjord area is also given in Table 1. The numbers of larval cod caught by the "Dana" with the 2 m stramin net in half-hour hauls are shown in Figure 2. The fjords and the banks yielded, however, very poor catches of larval cod. Just as in 1956 and 1957 the largest

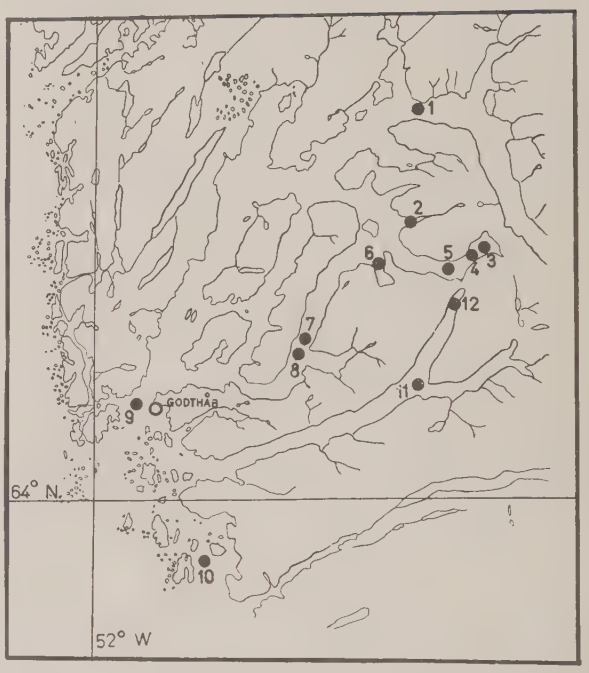


Figure 1. The position of the stations at which cod eggs were taken in 30-minute hauls with 1 m stramin and 1 m nylon net by "Adolf Jensen" and "Tornaq" with 100–50 m of wire out.

Table 1. Number of cod eggs and larvae taken in the Godthåb fjord area

Stations		March		April		May		June		July	
		1.–15.	15.–31.	1.–15.	15.–30.	1.–15.	15.–31.	1.–15.	15.–30.	1.–15.	15.–31.
3	Eggs	—	(3,190)	(350,000)	(105,000)	—	—	—	—	—	—
	Fry	—	—	—	—	—	—	—	—	—	—
4	Eggs	—	(4,350)	(78,400)	(148,000)	—	—	—	—	—	—
	Fry	—	—	—	—	—	—	—	—	—	—
5	Eggs	—	—	3,730	125,000	—	5,981	—	—	0	—
		—	(11,890)	(3,380)	(115,000)	—	(8,000)	—	—	(6)	—
	Fry	—	—	—	—	—	—	—	—	5	—
		—	—	—	—	—	—	—	—	(2)	—
6	Eggs	—	(27)	—	—	—	—	—	—	—	—
	Fry	—	—	—	—	—	—	—	—	—	—
7	Eggs	—	—	—	—	150	1370	—	—	—	—
	Fry	—	—	—	—	1	—	—	—	—	—
8	Eggs	—	9	—	84	—	147	—	—	0	—
		—	—	—	(81)	—	(106)	—	—	(0)	—
	Fry	—	—	—	—	—	—	—	—	1	—
		—	—	—	—	—	—	—	—	(1)	—
9	Eggs	—	1	—	36	60	—	—	—	0	—
		—	(0)	—	(52)	(81)	—	—	—	(2)	—
	Fry	—	—	—	—	—	—	—	—	1	—
		—	—	—	—	—	—	—	—	(8)	—
10	Eggs	—	0	—	—	10	—	—	8	—	—
		—	—	—	—	(8)	—	—	—	(0)	—
	Fry	—	—	—	—	—	—	—	14	—	—
		—	—	—	—	—	—	—	(1)	(1)	—

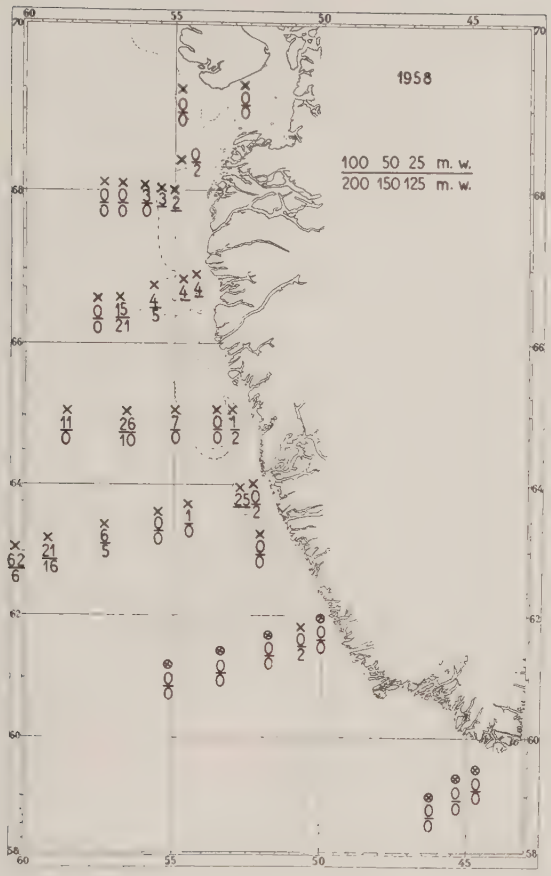


Figure 2. Catches of cod larvae in 30-minute hauls with 2 m stramin net by "Dana".

numbers of larval cod were found at the stations west of the banks.

The sparse occurrence of larval cod suggests that the 1958 year-class will be very poor.

Occurrence of age-groups I, II, and III

Small cod were taken in rather poor numbers with the small-mesh seine and the shrimp trawl. Details of the catches are given in Table 2, and the length distribution is shown in Figure 3. The

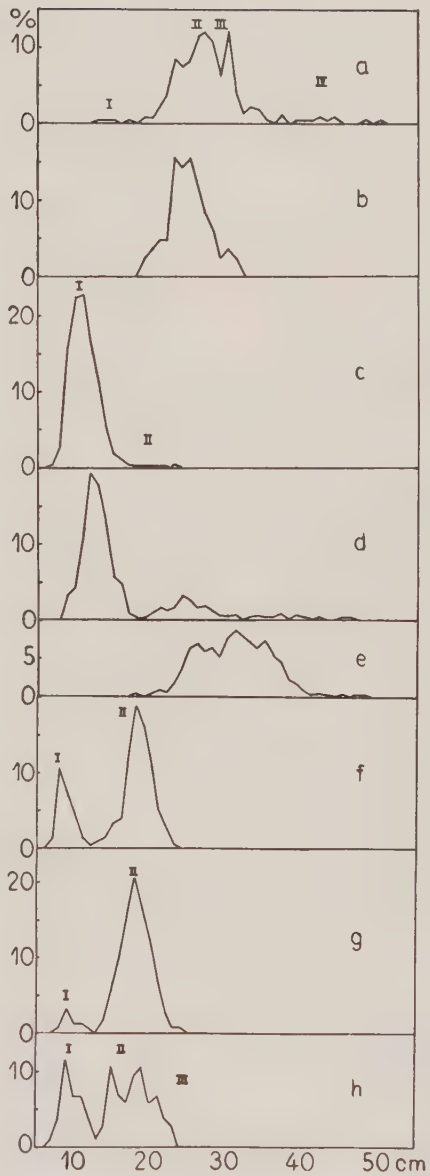


Figure 3. Length frequencies of small cod, age-groups I, II, and III.

Table 2.

Sample	Locality	Date	Gear	Number of fish
a	Frederikshåb district	11. 6.	seine	281 (ages determ.)
b	Frederikshåb district	13. 6.	seine	84
c	Godthåb district	5. 7.	seine	1989 (ages determ.)
d	Godthåb district	23. 7.	seine	608
e	Holsteinsborg district	15. 6.	seine	995
f	Godthåb district	30. 1.	shrimp trawl	239 (ages determ.)
g	Godthåb district	26. 2.	shrimp trawl	176 (ages determ.)
h	Godthåb district	14. 4.	shrimp trawl	104 (ages determ.)

greatest numbers were taken in catches c and e, 1989 and 995 fish respectively. On the basis of these observations it is rather difficult to draw any conclusions about the strength of the year-classes and their future importance to the commercial fishery. There is, however, evidence for concluding that the 1957 year-class is rich because large shoals of this class were observed in many localities on the coast where the structure of the bottom hindered fishing with the seine.

P. M. Hansen

COMMERCIAL FISH
COD

Greenland Stock

Cod Investigations in the Coastal Waters and on the Offshore Banks of West Greenland in 1958

(Figures 4–6; Tables 3–5)

1. The age composition

(a) *Offshore banks*

Age determinations were made on 1,135 cod from the banks, of these 879 were taken with hand-lines by "Dana" at the end of July and beginning of August, while 79 fish were caught by "Adolf Jensen" on 6. May. Ninety-seven were taken on hand-lines by "Sujumut" on 4. September and 80 fish with long-lines by "Immanuel" on 2. September. Figure 4 shows the age distribution in six of the eight samples (samples Nos. 7 and 8 are omitted but they are shown in Figure 5).

It is obvious that the 1953 year-class is greatly predominant (40—70%) in samples Nos. 1, 2, 3, and 7 (Table 3) (sub-areas A, B, C).

In sub-area D three samples were collected. In sample No. 4 the 1953 year-class predominated at

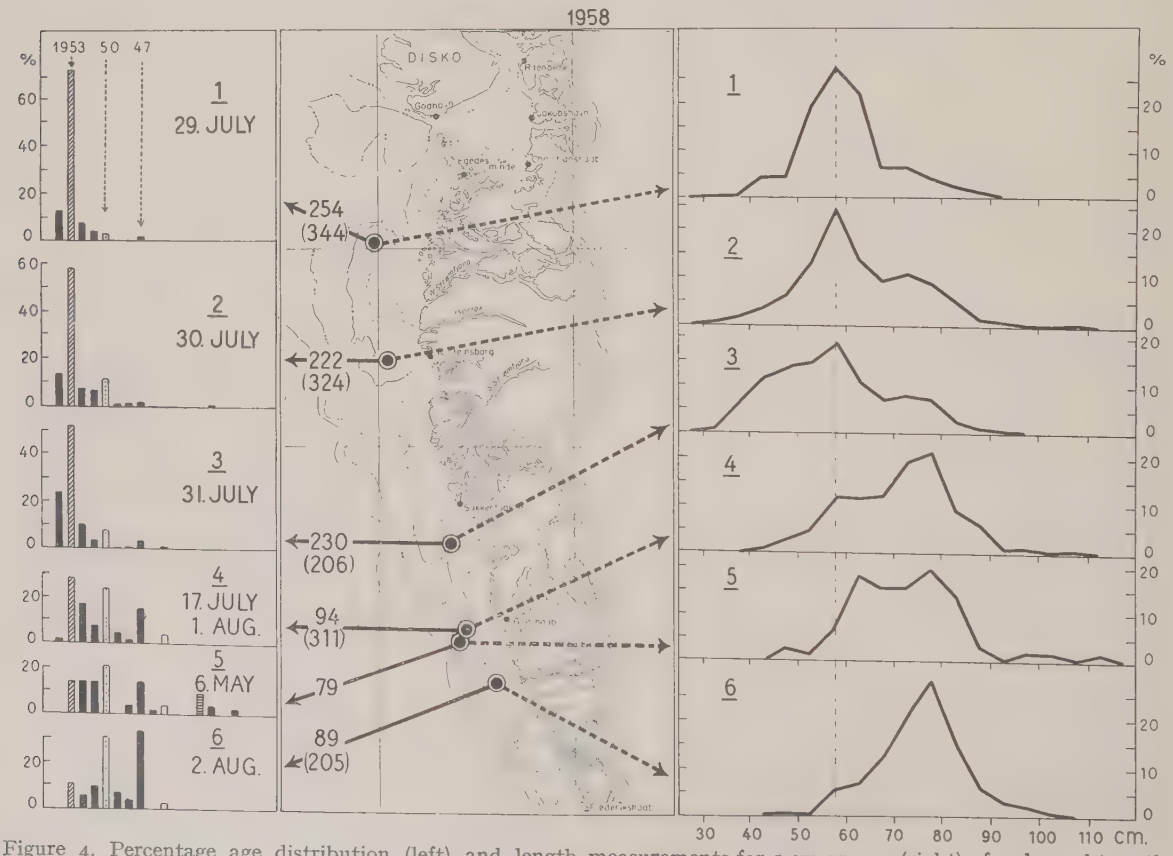


Figure 4. Percentage age distribution (left) and length measurements for 5 cm groups (right) of cod caught on the Greenland banks in 1958. The number of fish examined and that of cod tagged (bracketed figures) are given for each station.

Table 3. Age composition of the cod on West Greenland banks in 1958, together with the mean lengths of males and females at each age

Sample	1 Store Hellefiske Bank 68°03′N, 55°03′W 29. July, 51 m Hand-line			2 Store Hellefiske Bank 66°53′N, 54°45′W 30. July, 30–45 m Hand-line			3 Lille Hellefiske Bank 64°58′N, 53°10′W 31. July, 36–39 m Hand-line		
Year-class / Age-group	Nos.	Length, cm ♂♂	Length, cm ♀♀	Nos.	Length, cm ♂♂	Length, cm ♀♀	Nos.	Length, cm ♂♂	Length, cm ♀♀
1954 IV	31	44.5	46.6	29	47.3	48.8	51	44.1	45.0
1953 V	182	55.3	54.9	129	55.7	56.3	114	55.4	54.5
1952 VI	20	62.4	61.6	16	60.5	64.9	23	63.4	64.4
1951 VII	10	69.3	67.7	15	72.2	70.1	7	69.8	71.0
1950 VIII	8	75.0	76.9	26	74.1	75.8	16	71.8	68.8
1949 IX	—	—	—	1	84.0	—	1	—	78.0
1948 X	—	—	—	2	79.0	—	1	—	79.0
1947 XI	3	81.0	79.0	3	78.0	83.0	6	—	78.3
1945 XIII	—	—	—	—	—	—	1	—	94.0
1943 XV	—	—	—	1	90.0	—	—	—	—
Total number	254			222			220		

Sample	4 Fylla Bank 64°08′N, 52°43′W 17. July, 1. Aug., 45 m Hand-line			5 Fylla Bank 63°55′N, 53°00′W 6. May, 180–300 m Long-line			6 Fiskenæs Bank 63°27′N, 52°00′W 2. Aug., 50–55 m Hand-line		
Year-class / Age-group	Nos.	Length, cm ♂♂	Length, cm ♀♀	Nos.	Length, cm ♂♂	Length, cm ♀♀	Nos.	Length, cm ♂♂	Length, cm ♀♀
1954 IV	1	—	48.0	—	—	—	—	—	—
1953 V	26	56.8	55.6	11	55.1	60.5	9	56.0	59.0
1952 VI	16	65.9	66.4	11	63.6	63.0	5	64.5	68.7
1951 VII	7	75.7	73.0	11	68.6	72.0	8	70.2	68.0
1950 VIII	22	76.3	75.4	16	69.4	74.9	27	73.3	75.1
1949 IX	4	74.0	79.0	—	—	—	6	77.5	73.5
1948 X	1	—	86.0	3	77.0	—	3	—	78.0
1947 XI	14	77.4	79.1	11	77.7	79.3	29	81.1	80.6
1946 XII	—	—	—	1	—	85.0	—	—	—
1945 XIII	3	80.0	87.0	3	81.0	82.0	2	97.0	82.0
1942 XVI	—	—	—	7	80.5	81.2	—	—	—
1941 XVII	—	—	—	3	85.0	100.5	—	—	—
1939 XIX	—	—	—	2	78.0	112.0	—	—	—
Total number	94			79			89		

Sample	7 Store Hellefiske Bank 66°54′N, 54°07′W 4. Sept., 50–100 m Hand-line			8 Frederikshåb Bank 62°10′N, 50°43′W 2. Sept., 75–120 m Long-line		
Year-class / Age-group	Nos.	Length, cm ♂♂	Length, cm ♀♀	Nos.	Length, cm ♂♂	Length, cm ♀♀
1954 IV	2	51.0	56.0	—	—	—
1953 V	41	61.5	60.4	—	—	—
1952 VI	14	71.0	68.7	—	—	—
1951 VII	2	72.0	81.0	1	—	68.0
1950 VIII	20	75.6	77.5	2	71.5	—
1949 IX	—	—	—	1	—	80.0
1948 X	4	80.5	84.0	3	—	77.0
1947 XI	12	83.8	84.6	43	74.1	78.9
1946 XII	1	—	82.0	3	79.0	97.0
1945 XIII	1	—	97.0	11	79.8	81.6
1943 XV	—	—	—	3	78.0	84.5
1942 XVI	—	—	—	12	83.0	90.0
1938 XX	—	—	—	1	85.0	—
Total number	97			80		

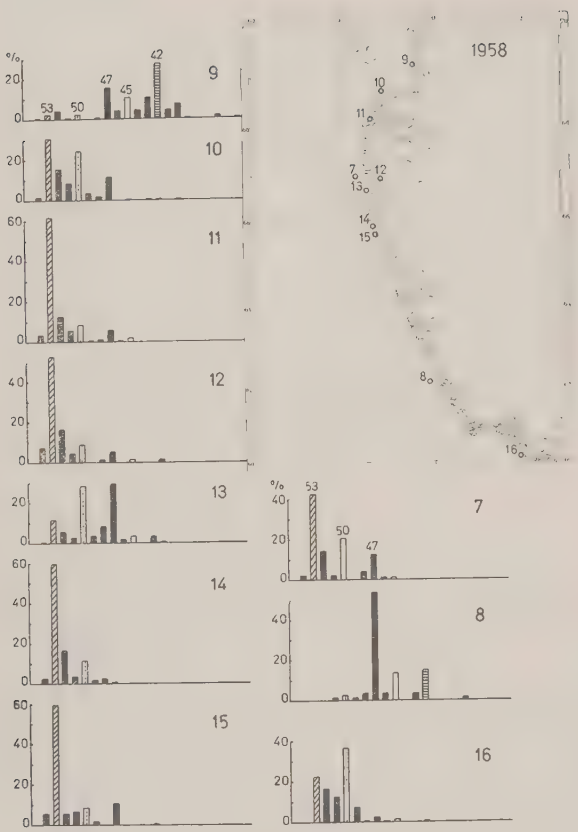


Figure 5. Percentage age distribution of cod caught in the coastal area of West Greenland in 1958 (samples Nos. 7 and 8 are taken on the banks).

about 25%. In sample No. 5 the 1950 year-class was the most important, and in No. 6 the 1947 class predominated at about 30%.

One sample only was taken in sub-area E, viz. No. 8. It was caught on long-lines on 2. September and the 1947 year-class predominated at 58%.

Judging from the above-mentioned samples there is evidence for an increasing strength of the 1953 year-class, especially in sub-areas B and C, while the 1950 and 1947 year-classes have fallen off.

The year-classes of 1950 and 1947 are only prominent in samples from sub-areas D and E.

The length frequencies of the catches, shown in Figure 4 in the right-hand column, are in agreement with the age compositions in so far as the three northernmost catches contain chiefly small fish, while the cod in samples Nos. 4, 5, and 6 are considerably larger.

(b) *Inshore waters and fjords*

Age determinations were made on 3,764 cod taken in inshore waters and the fjords; of these fish 2,440 were taken in 17 hauls in the Godthåb fjord, while the remaining 1,324 fish were spread over eight hauls. The age compositions and the stations are shown in Figures 5 and 6 and the data are set out in Tables 4 and 5.

According to sub-areas the catches were the following:—

Sub-areas	1A	1B	1C	1D	1E	1F
Number of samples	1	4	2	17	0	1

Table 4. Age composition from inshore waters and fjords of West Greenland in 1958

Year-class	Samples Age-group	9 July Aug. Sept. Nov.	10 Aug. Sept.	11 Aug.	12 July	13 Oct.	14 July Aug.	15 July	16 July
1954	IV	1	2	6	13	1	3	8	—
1953	V	3	49	121	89	18	64	81	62
1952	VI	5	25	24	27	9	18	8	47
1951	VII	1	14	11	8	4	4	9	36
1950	VIII	3	39	16	15	44	12	12	103
1949	IX	—	6	1	—	6	2	2	20
1948	X	1	3	2	2	13	3	—	1
1947	XI	19	18	11	9	46	1	14	7
1946	XII	5	—	1		3	—	—	1
1945	XIII	13	1	3	2	5	—	—	3
1944	XIV	6	—	—	—	—	—	—	—
1943	XV	13	1	—	—	5	—	1	—
1942	XVI	34	1	—	2	1	—	—	1
1941	XVII	6	—	—	—	-	—	—	—
1940	XVIII	9	1	—	—	—	-	—	—
1939	XIX	1	—	—	—	—	—	—	—
1936	XXII	2	—	—	-	—	—	—	—
1934	XXIV	1	—	—	—	—	—	—	—
Total number		123	160	196	167	155	107	135	281

Figure 6. Percentage age distribution of cod caught in the Godthåb fjord area in 1958.

In the chart (Fig. 5) 10 samples are shown. Sample No. 7 came, however, from the banks and has been described together with the bank catches. The same is the case with sample No. 8, taken in sub-area 1E. The catches in 1D (Fig. 6) all came from the Godthåb fjord and the neighbouring coastal area.

Sample No. 9 was taken in sub-area 1A. In this area the stock of cod, and consequently the fishery also, has declined greatly and in 1958 it was almost negligible. The most prominent year-class was that of 1942, in accordance with the fact that old fish are predominant in this northern area. At nearly all the coastal stations the 1953 year-class was very strongly represented, just as on the banks. In sample No. 13 taken with long-line in the Holsteinsborg Deep, the 1947 year-class is, however, predominant, and in sample No. 16, taken in sub-area 1F the 1950 year-class is the most prominent.

Table 5. Age composition from Godthåb fjord in 1958

Year-class	Samples Age-group	1 Febr. Hand-line	2 March Hand-line	3 April Hand-line	4 May Long-line	5 May Hand-line	6 Febr. Hand-line	7 July Hand-line	8 Febr. Long-line	9 Jan. Long-line
1955	III	—	—	—	—	3	4	13	—	—
1954	IV	—	—	—	—	16	18	39	1	2
1953	V	13	23	1	5	34	66	30	1	1
1952	VI	93	75	26	46	41	114	79	14	33
1951	VII	8	8	15	7	6	5	3	1	2
1950	VIII	34	14	28	13	3	6	3	1	—
1949	IX	12	3	23	9	3	3	1	3	3
1948	X	2	5	7	1	2	—	1	—	—
1947	XI	18	9	32	7	2	6	—	2	6
1946	XII	1	2	4	1	—	—	—	—	1
1945	XIII	15	12	34	9	—	2	1	6	10
1944	XIV	2	2	1	—	—	—	1	1	1
1943	XV	9	3	6	1	1	3	1	1	1
1942	XVI	3	4	11	—	—	1	—	3	7
1941	XVII	—	—	1	—	—	—	—	—	—
1940	XVIII	2	4	9	1	2	—	—	3	3
1939	XIX	—	1	—	—	—	—	—	—	—
1938	XX	1	—	1	—	—	—	—	1	1
1937	XXI	—	—	—	—	1	—	—	—	—
1936	XXII	—	1	—	—	—	—	—	1	—
Total number		213	166	199	100	114	228	172	39	71

Year-class	Samples Age-group	10 Febr. Long-line	11 April Hand-line	12 Aug. Hand-line	13 July Hand-line	14 July Hand-line	15 April/May Hand-line	16 July Hand-line	17 May Hand-line
1955	III	—	—	17	39	2	11	—	—
1954	IV	—	12	40	44	27	17	2	12
1953	V	1	93	7	52	102	78	64	94
1952	VI	39	76	17	23	49	17	24	19
1951	VII	3	11	1	4	5	2	6	6
1950	VIII	2	16	3	6	11	4	24	1
1949	IX	2	1	1	1	1	—	2	1
1948	X	1	1	1	—	—	—	—	—
1947	XI	2	3	—	—	3	—	9	—
1946	XII	1	—	—	—	—	—	1	—
1945	XIII	3	5	—	1	—	2	—	—
1944	XIV	2	—	—	—	—	—	—	—
1943	XV	—	—	—	—	—	—	—	—
1942	XVI	5	1	1	—	1	—	—	—
1941	XVII	1	1	—	—	—	—	—	—
1940	XVIII	1	—	—	—	—	—	—	—
1939	XIX	—	—	—	—	—	—	—	—
1938	XX	—	—	—	—	—	—	—	—
1937	XXI	—	—	—	—	—	—	—	—
1936	XXII	—	—	—	—	—	—	—	—
Total number		63	220	88	170	201	131	132	133

In the Godthåb fjord area (Fig. 6) the 1953 year-class was predominant at the entrance to the fjord, whilst the 1952 class was very prominent in the catches taken in the fjord itself; this brood has only been of any importance in the Godthåb fjord. As usual, an even distribution in the spawning shoals of chiefly old year-classes was observed in April in the Godthåb fjord (No. 3, Fig. 6), the 1945 and 1947 classes being predominant.

The distribution of the catches as to sub-areas was, however, not so even as required for an assessment of age composition for the entire West Greenland cod population. From sub-area 1E we have thus no samples and from 1F only a single one.

Table 6. Age at first maturity of the 1942, 1945, and 1947 year-classes of Greenland cod in 1958

Banks off the west coast

Age	1942 year-class Nos. ♂♂	%	Nos. ♀♀	%	Age	1945 year-class Nos. ♂♂	%	Nos. ♀♀	%	Age	1947 year-class Nos. ♂♂	%	Nos. ♀♀	%
imm.	—	—	—	—	imm.	—	—	—	—	imm.	—	—	—	—
6	1	14.3	1	8.3	6	1	9.1	1	10.0	6	3	4.1	—	—
7	4	57.1	7	58.3	7	5	45.5	—	—	7	39	53.4	17	36.2
8	1	14.3	4	33.3	8	4	36.4	7	70.0	8	27	37.0	22	46.8
9	1	14.3	—	—	9	—	—	2	20.0	9	4	5.5	6	12.8
10	—	—	—	—	10	—	—	—	—	10	—	—	2	4.3
11	—	—	—	—	11	1	9.1	—	—	11	—	—	—	—
Total	7		12			11		10			73		47	
Mean		7.1		7.2			7.6		8.0			7.4		7.9

Coastal area north of 63°N

Age	Nos. ♂♂	%	Nos. ♀♀	%	Age	Nos. ♂♂	%	Nos. ♀♀	%	Age	Nos. ♂♂	%	Nos. ♀♀	%
imm.	—	—	—	—	imm.	—	—	—	—	imm.	—	—	2	3.6
5	—	—	—	—	5	—	—	—	—	5	1	1.6	—	—
6	3	20.0	1	4.3	6	1	10.0	1	7.1	6	—	—	—	—
7	9	59.9	14	60.9	7	2	20.0	5	35.7	7	26	41.9	9	16.1
8	2	13.3	5	21.7	8	3	30.0	7	50.0	8	25	40.3	25	44.6
9	1	6.7	3	13.0	9	4	40.0	1	7.1	9	10	16.1	18	32.1
10	—	—	—	—	10	—	—	—	—	10	—	—	2	3.6
Total	15		23			10		14			62		56	
Mean		7.1		7.4			8.0		7.6			7.7		8.2

Godthåb fjord

Age	Nos. ♂♂	%	Nos. ♀♀	%	Age	Nos. ♂♂	%	Nos. ♀♀	%	Age	Nos. ♂♂	%	Nos. ♀♀	%
imm.	—	—	—	—	imm.	—	—	—	—	imm.	1	2.4	—	—
6	1	5.6	3	18.8	6	6	13.6	8	16.0	6	5	12.2	8	14.0
7	13	72.1	6	37.5	7	26	59.1	24	48.0	7	14	34.1	19	33.3
8	2	11.1	5	31.3	8	8	18.2	12	24.0	8	18	43.9	25	43.9
9	2	11.1	1	6.3	9	3	6.8	5	10.0	9	2	4.9	4	7.0
10	—	—	1	6.3	10	1	2.3	1	2.0	10	1	2.4	1	1.8
Total	18		16			44		50			41		57	
Mean		7.3		7.4			7.3		7.3			7.5		7.5

East coast

Age	Nos. ♂♂	%	Nos. ♀♀	%	Age	Nos. ♂♂	%	Nos. ♀♀	%	Age	Nos. ♂♂	%	Nos. ♀♀	%
imm.	—	—	—	—	imm.	1	5.3	1	3.2	imm.	1	2.1	3	6.1
6	4	13.3	2	2.7	6	3	15.8	1	3.2	6	2	4.3	—	—
7	13	43.3	33	43.9	7	7	36.8	8	25.8	7	16	34.0	14	28.6
8	10	33.3	31	41.2	8	4	21.1	8	25.8	8	19	40.4	18	36.7
9	3	10.0	5	6.7	9	2	10.5	4	12.9	9	8	17.0	10	20.4
10	—	—	2	2.7	10	1	5.3	7	22.6	10	1	2.1	4	8.2
11	—	—	2	2.7	11	1	5.3	2	6.5	11	—	—	—	—
Total	30		75			19		31			47		49	
Mean		7.4		7.9			7.7		8.5			7.8		8.1

It is generally believed that some of the data dispatched from Greenland were lost in a shipwreck on 30. January 1959.

According to the material in hand it seems that the 1947 and 1950 year-classes are decreasing, especially in the northern part of the area, whilst the 1953 year-class is increasing. It is therefore suggested that this year-class will contribute largely to the fisheries in 1959. In 1958, the length of the fish ranged between 55 cm and 60 cm, the weight averaging 2 kg; in 1959, the mean length will be about 65 cm and the average weight about 3 kg.

Age at first maturity

Investigations on age at first maturity have been made by means of the otoliths of cod from the following areas: the West Greenland banks, the coastal area north of 63°N (1A, 1B, 1C), south of 63°N (1F), the Godthåb fjord, and the Angmagssalik district in East Greenland. Only cod of the old, rich year-classes of 1942, 1945, and 1947 were examined. For these year-classes no greater difference in age at first maturity has been observed. In female cod there was a trend towards attaining maturity at an older age than the males.

Table 7. Age composition of cod in East Greenland in 1958, together with mean lengths of males and females at each age

Year-class	Age-group	1 Angmagssalik Bank abt. 65°20′N, 37°00′W Aug., Sept., 160–200 m Long-line Nos.	Length, cm ♂♂	Length, cm ♀♀	2 Angmagssalik Bank 65°21′N, 37°01′W 22. Aug., 170–200 m Hand-line Nos.	Length, cm ♂♂	Length, cm ♀♀	3 Angmagssalik 65°35′N, 37°35′W 25. Aug., 80–150 m Hand-line Nos.	Length, cm ♂♂	Length, cm ♀♀
1954	IV	4	47.0	55.0	2	50.0	—	33	52.5	52.9
1953	V	5	64.0	56.3	2	56.0	56.0	11	59.5	62.1
1952	VI	6	66.0	65.5	3	62.5	53.0	28	65.3	64.2
1951	VII	7	66.0	75.3	2	71.0	89.0	35	70.1	68.8
1950	VIII	15	79.9	75.9	22	85.7	85.7	51	74.7	73.9
1949	IX	7	90.0	88.6	4	95.0	92.5	8	80.7	76.5
1948	X	—	—	—	1	—	92.0	—	—	—
1947	XI	6	80.5	94.3	1	—	90.0	—	—	—
1946	XII	—	—	—	—	—	—	—	—	—
1945	XIII	3	104.0	89.0	—	—	—	1	—	88.0
1944	XIV	—	—	—	—	—	—	—	—	—
1943	XV	2	105.0	106.0	—	—	—	—	—	—
1942	XVI	17	108.0	113.4	—	—	—	1	—	102.0
1941	XVII	2	—	108.5	—	—	—	—	—	—
1940	XVIII	1	—	111.0	—	—	—	—	—	—
1939	XIX	4	—	116.8	—	—	—	—	—	—
Total number		79			37			168		

Year-class	Age-group	4 Angmagssalik fjord 65°49′N, 37°01′W Sept., 150 m Hand-line Nos.	Length, cm ♂♂	Length, cm ♀♀	5 Off Skjoldungen 63°09′N, 40°55′W 8. Aug., 160–200 m Long-line Nos.	Length, cm ♂♂	Length, cm ♀♀	6 Off Skjoldungen 63°09′N, 40°55′W 8. Aug., 170 m Hand-line Nos.	Length, cm ♂♂	Length, cm ♀♀
1954	IV	28	53.3	54.3	—	—	—	1	45.0	—
1953	V	28	59.7	62.7	—	—	—	—	—	—
1952	VI	40	65.3	66.4	1	—	67.0	7	61.4	64.0
1951	VII	46	71.4	73.3	10	69.3	68.1	12	66.4	70.6
1950	VIII	115	77.4	77.4	33	73.2	73.4	69	75.8	74.7
1949	IX	19	80.1	80.9	15	78.8	80.0	27	80.3	80.5
1948	X	1	77.0	—	3	—	74.0	1	82.0	—
1947	XI	2	84.0	86.0	31	78.3	80.4	7	82.5	80.5
1946	XII	—	—	—	4	82.5	85.5	—	—	—
1945	XIII	2	—	105.5	18	88.1	86.5	6	85.8	85.5
1944	XIV	—	—	—	2	91.0	93.0	—	—	—
1943	XV	—	—	—	8	85.3	93.0	1	94.0	—
1942	XVI	1	—	122.0	30	95.1	98.1	3	83.0	86.0
1941	XVII	—	—	—	1	—	100.0	—	—	—
1940	XVIII	—	—	—	2	—	105.0	—	—	—
1939	XIX	—	—	—	1	—	116.0	—	—	—
1938	XX	—	—	—	2	—	119.5	—	—	—
1937	XXI	—	—	—	1	—	134.0	—	—	—
1936	XXII	—	—	—	2	—	105.0	—	—	—
Total number		282			164			134		

East Greenland

(Figure 7; Table 7)

Investigations in the Angmagssalik district, commenced in 1957 continued in the period 5. August to 22. September.

During the period 8. to 14. August large concentrations of cod occurred at Skjoldungen (63°N) both on the bank and off shore at a depth of 170 m. The fish were encountered below the polar water which formed a layer in a depth of 30—140 m. On 8. August good catches were made on the bank off Skjoldungen both by long-lines and hand-lines (Fig. 7, Nos. 5 and 6 and Table 7, columns 5 and 6). The two fisheries were operated in the same locality and depth, the catches, however, differed widely in age and length compositions; the long-line catches contained the 1942, 1947, and 1950 year-classes in almost equal numbers (15—20%), whilst the 1950 year-class in the hand-line catches amounted to

Table 7 (continued)

Sample		7 Skjoldungen Bank 63°07′N, 40°52′W 12. Aug., 160–200 m Long-line			8 Anarnitsoq 63°10′N, 43°14′W 13. Aug., 150–170 m Hand-line		
Year-class	Age-group	Nos.	Length, cm ♂♂	Length, cm ♀♀	Nos.	Length, cm ♂♂	Length, cm ♀♀
1954	IV	—	—	—	1	—	44.0
1953	V	—	—	—	5	54.0	58.0
1952	VI	—		—	10	60.6	64.6
1951	VII	1	70.0	—	11	69.4	66.0
1950	VIII	7	78.4	74.0	50	74.9	72.0
1949	IX	9	84.0	82.2	15	80.4	77.4
1948	X	1	81.0	—	—	—	-
1947	XI	34	76.3	84.3	4	78.0	76.0
1946	XII	2	—	85.5	—	—	—
1945	XIII	14	82.3	94.1	—	—	—
1944	XIV	3	87.5	92.0	—	—	—
1943	XV	8	86.0	93.6	—	-	—
1942	XVI	39	91.1	97.6	3	96.0	100.0
1941	XVII	1	—	97.0	—	—	—
1940	XVIII	2	101.0	103.0	—	—	—
1936	XXII	4	94.0	99.0	—	—	—
1934	XXIV	1	—	109.0	-	—	—
Total number		126			99		

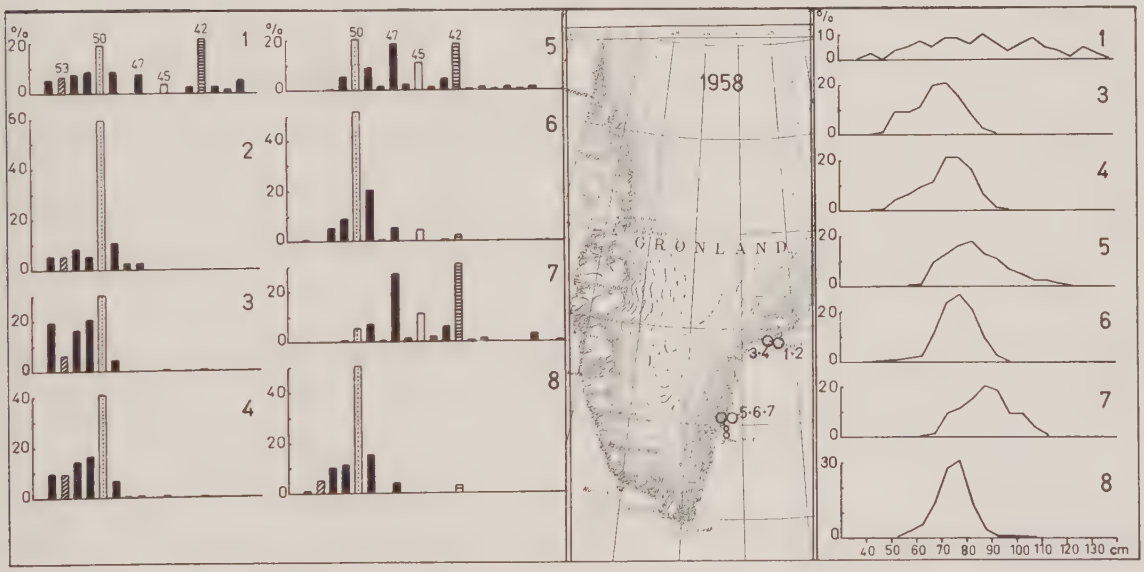


Figure 7. Percentage age distribution (left) and length measurements for 5 cm groups (right) of cod caught in the Angmagssalik district, East Greenland 1958.

more than 50%, and the older year-classes were represented by less than 5%. In the latter catch the 1949 year-class was second in order, at 20%.

On 12. and 13. August two samples were obtained, one by long-lines on Skjoldungen Bank (No. 7) and the other by hand-lines at the entrance to the Skjoldungen Sound (No. 8). In these samples it was also observed that the long-line catch contained the rich, old 1942 and 1947 year-classes, whereas the hand-line catch was dominated by the 1950 year-class (50%). Since the 1950 year-class in the long-line sample taken on the bank only provided 5% of the catch and this year-class was so abundantly represented in the hand-line fishery operated from the shore there is evidence for believing that the 1950 year-class has migrated to the coastal area.

In the samples from Angmagssalik Bank (Nos. 1 and 2) the same age-composition difference is found for long-line and hand-line samples. In sample No. 3 from the coastal area off Angmagssalik many younger year-classes were represented, and the 1950 year-class predominated at 30%. This year-class was more numerous in Angmagssalik fjord (No. 4), providing 40% of the catch. The cod fishery, which in 1958 was operated for the first time in this fjord depended largely on the 1950 class. A movement of cod into the fjord also occurs at Angmagssalik; thus, at the beginning of September almost no cod were observed on the bank and the long-lines took almost exclusively halibut, but at the same time very rich concentrations of cod occurred in the fjord itself. In the sample comprising 37 cod caught on 22. August by long-lines on the Angmagssalik Bank 22 fish belonged to the 1950 year-class. These cod were unusually large, the mean length being 85.7 cm, that is, 8—10 cm longer than the average lengths found for that year-class at other East Greenland stations. The fast growth indicates that these 22 cod belonged to the Icelandic stock; none of the fish were mature. They were presumably Icelandic cod on feeding migration to East Greenland waters.

Tagging Experiments

(Tables 8–10)

In 1958, 2,881 cod were tagged in West Greenland waters; of these, 1,300 fish were tagged on the banks and 1,581 in the coastal region and fjords, inclusive of 657 fish in the Godthåb fjord. At East Greenland, in the Angmagssalik district, 1,015 cod were marked.

There were 788 recaptures of cod marked in West Greenland waters. Of these, 771 fish were recovered at West Greenland, 16 at Iceland, and one at East Greenland. The recoveries of the marked fish of different ages are given in Table 8. The recapture at East Greenland was reported by a German trawler which had caught the marked fish on 7. March 1958 at Angmagssalik; it was tagged on 7. September 1954 in sub-area 1F. The fish recovered at Iceland were tagged in the following sub-areas:—

1B	1C	1D	1E	1F
1	3	8	1	3

Otoliths of 509 recaptured cod were forwarded. The age determinations showed that about 75% of the fish belonged to the 1950, 1947, 1952, and

Table 8. Tagged cod recaptured at Greenland (Gr.) and at Iceland (Ic.) in 1958, tabulated according to age and year of liberation

Year-class	Age-group	1951 Gr.	1951 Ic.	1952 Gr.	1952 Ic.	1953 Gr.	1953 Ic.	1954 Gr.	1954 Ic.	1955 Gr.	1955 Ic.	1956 Gr.	1956 Ic.	1957 Gr.	1957 Ic.	1958 Gr.	1958 Ic.	Total Gr.	Total %	Total Ic.
1938	XX	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	0.2	—
1940	XVIII	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	0.2	—
1942	XVI	—	—	—	—	—	—	2	—	—	—	2	—	6	—	1	—	11	2.2	—
1943	XV	—	—	—	—	1	—	1	—	—	—	—	—	1	—	—	—	3	0.6	—
1945	XIII	—	—	—	—	—	—	4	1	1	—	—	—	9	1	—	—	14	2.8	2
1946	XII	—	—	—	—	—	—	—	—	2	—	1	—	2	—	—	—	5	1.0	—
1947	XI	—	—	2	—	1	—	11	—	10	—	28	—	42	—	10	—	104	20.9	—
1948	X	—	—	—	—	—	—	—	—	1	—	2	—	3	—	1	—	7	1.4	—
1949	IX	—	—	—	—	—	—	2	1*)	4	—	2	1	6	2	—	—	14	2.8	4*)
1950	VIII	—	—	—	—	—	—	3	—	16	—	16	—	65	3	13	—	113	22.7	3
1951	VII	—	—	—	—	—	—	—	—	1	—	1	—	26	1	3	—	31	6.2	1
1952	VI	—	—	—	—	—	—	—	—	—	1	4	—	77	—	4	—	85	17.0	1
1953	V	—	—	—	—	—	—	—	—	—	—	—	—	53	—	15	—	68	13.7	—
1954	IV	—	—	—	—	—	—	—	—	—	—	2	—	28	—	3	—	33	6.6	—
1955	III	—	—	—	—	—	—	—	—	—	—	—	—	7	—	1	—	8	1.6	—
??		2	—	—	—	4	—	20	3	19	1	58	2	125	—	45	—	273		6
Total number		2	—	2	—	6	—	45	5*)	54	2	116	3	450	7	96	—	771	—	17*)

*) One cod recaptured at East Greenland.

Table 9. Cod tagged at West Greenland in different years and recaptured in 1958

	West Greenland	Iceland	East Greenland
Greenland	253	—	—
Faroe Islands	12	—	—
Norway	15	—	—
Iceland	25	9	—
United Kingdom	22	2	—
France	9	—	—
Germany	36	5	1
U.S.S.R.	2	—	—
Spain	13	—	—
Portugal	384	—	—
Total	771	16	1

Table 10. Cod tagged at East Greenland in 1957 and recaptured in 1958

	East Greenland	Iceland
Iceland	—	2
Germany	1	—
Total	1	2

1953 year-classes. The 1952 year-class accounts for 17% of the recaptured cod, due to the large amount of tagging experiments performed in 1957 and 1958, totalling more than 2,000 in the Godthåb fjord where this year-class formed a very large part of the stock. No less than 56 cod were recaptured in 1958 in Godthåb fjord itself. In other localities at West Greenland this year-class is of no importance.

In Table 9 are presented numbers of recaptures reported by the various countries. As usual Portugal reported the highest numbers, about one-half, while the Greenlanders reported about one-third of the recaptures from sub-area 1.

From the tagging experiments at East Greenland in 1957 three recaptures were reported in 1958; two from Iceland and one from East Greenland. The latter was reported by a German trawler. The cod was tagged on 16. September 1957 at Angmagssalik (65°35′N, 37°35′W) and recaptured on 22. September 1958 at position 66°50′N, 35°45′W. The two recaptures from Iceland are from the same experiment, they were recovered at West and North Iceland on 26. April and 15. June respectively.

P. M. Hansen

Norwegian Investigations in Greenland Waters in 1958

(Figures 8–13; Tables 11–13)

In 1958 a Norwegian fleet of 77 vessels participated in the fisheries on the Newfoundland banks and the banks off West Greenland. 68 of these vessels were engaged in the cod fisheries while 8 fished exclusively for halibut. One vessel fished both for halibut and cod. In this year 6 Norwegian trawlers visited the area.

A total of 13,420 tons of salted cod was landed from the area in 1958.

As in earlier years the fisheries off West Greenland started in early May in 1958. In June the fishery was relatively good on Fiskenæs Bank and on the southern part of Fylla Bank. As usual there was a slack period in the fishery in the first part of July. In late July there was a relatively good hand-line fishery on the banks between Færingerhavn and Sukkertoppen, but the really good hand-line fishery off Holsteinsborg did not start before the middle of August.

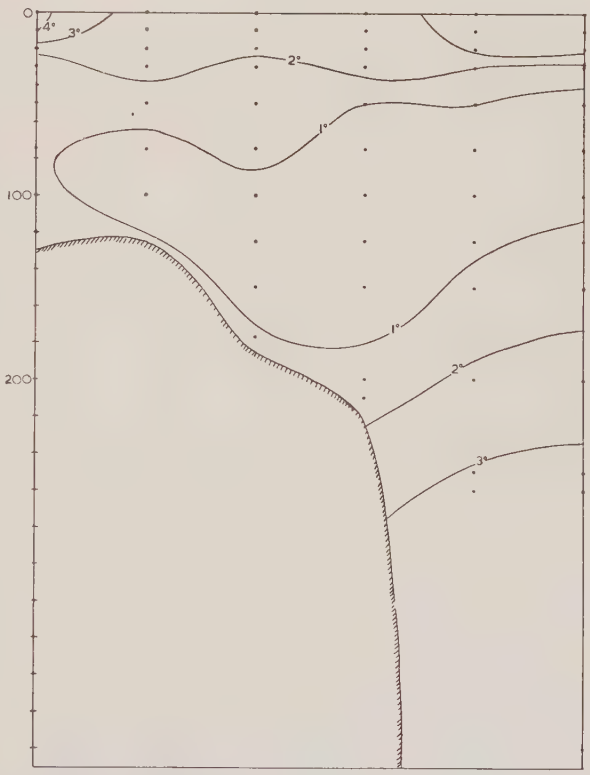


Figure 8. Temperature section of the northern part of Lille Hellefiske Bank westwards, taken by bathythermograph on 5. July 1958.

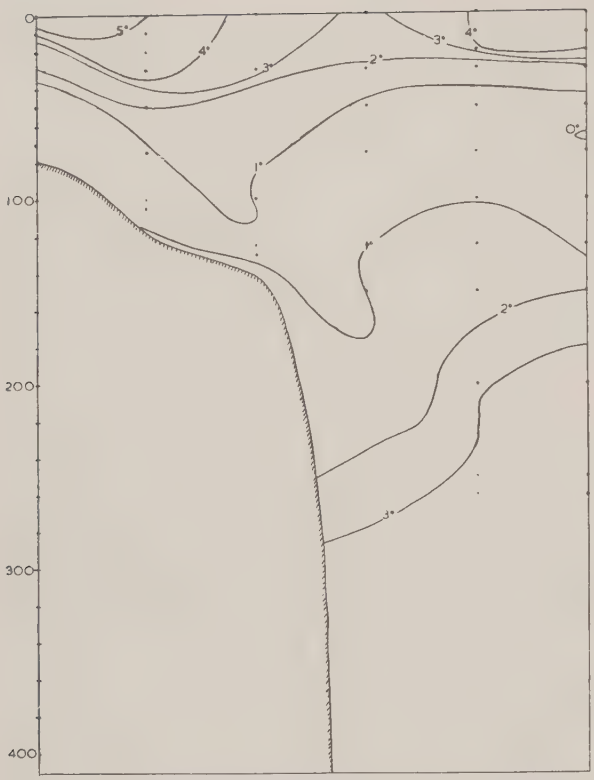


Figure 9. Temperature section across the middle part of Lille Hellefiske Bank and westwards. Bathythermograph, 5.–6. July 1958.

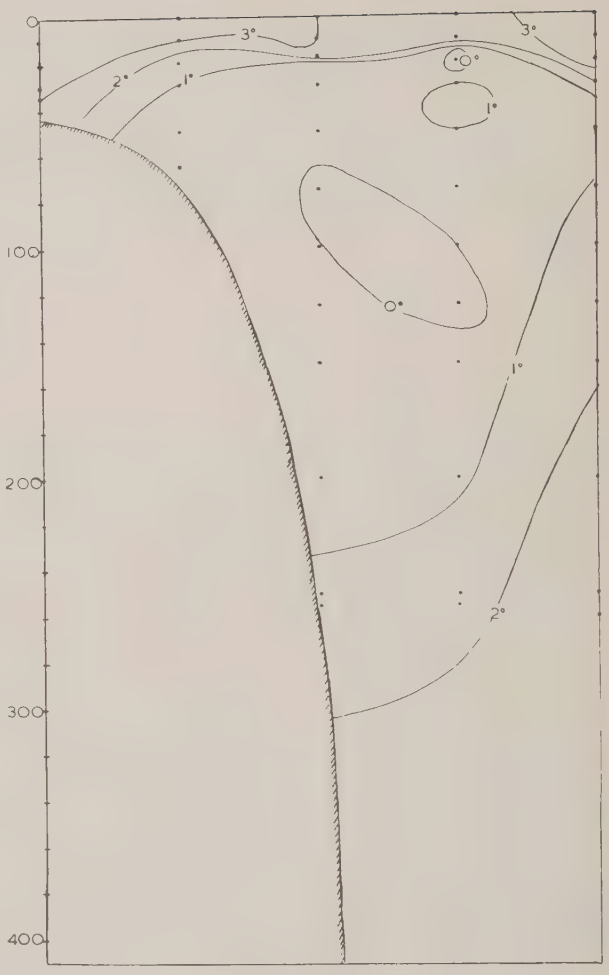


Figure 10. Temperature section from Fylla Bank westwards. Bathythermograph, 6. July 1958.

In the first part of June the cod was of relatively small size and the liver content was rather poor while the fish mostly fed on benthic animals. Towards the end of June and the rest of the season the mean length of the cod grew larger. From the middle of July the liver content also increased while the fish began to feed heavily on sand-eels.

Material was also this year sampled by an observer from the Norwegian Institute of Marine Research for the study of age and size composition of the commercial cod catches and for the study of the temperature conditions on the banks. The observer worked on board a commercial fishing vessel.

Temperature/fishery

Three temperature sections westwards from the banks were taken on 5.—6. July. Temperature registrations were also made where the vessel actually was fishing. All the temperature registrations were made by means of a bathythermograph.

Compared with earlier years the temperature sections showed no exceptional changes.

On Lille Hellefiske Bank (Figs. 8 and 9), a core of cold arctic water with temperatures of 0.5—2°C

Table 11. Bottom temperatures and catch of cod by a Norwegian commercial fishing vessel in the period 20. June to 4. July

Position	Depth, m	Bottom temperature, °C	Number of cod in the catch	Catch/10 hooks
N 62°57′, W 51°05′	360	>2	370	1.6
N 62°54′, W 51°05′	110	0.5	660	0.8
N 63°23′, W 51°50′	161	0.9	250	0.6
Southern part of Fiskenæs Bank	285	3.8	2,400	2.0
N 63°03′, W 51°50′	285	3.9	1,750	1.9
N 63°00′, W 51°52′	280	2.5	3,550	2.4
N 63°00′, W 51°54′	280	3.0	3,400	2.3
N 63°00′, W 52°02′	260	2.5	2,600	1.7
N 62°58′, W 52°05′	280	2.2	2,700	1.6
N 66°28′, W 54°20′	200	0.6	360	0.9
N 66°25′, W 54°23′	120	1.3	360	0.7
N 65°42′, W 54°15′	120	0.6	620	1.0
N 62°59′, W 52°00′	184	1.4	300	0.8

Table 12. Length frequencies of cod at West Greenland in 1958

3 cm groups	Lille Hellefiske Bank, July, Bottom long-line			Fiskenæs Bank/Fylla Bank, June, Bottom long-line		
	♀♀	♂♂	Total	♀♀	♂♂	Total
48– 50..	—	—	—	0.095	—	0.095
51– 53..	0.335	0.335	0.670	0.854	0.190	1.044
54– 56..	0.335	1.003	1.338	1.613	1.708	3.321
57– 59..	0.335	0.669	1.004	2.467	2.846	5.313
60– 62..	2.007	0.335	2.342	1.992	2.277	4.269
63– 65..	1.338	3.345	4.683	2.372	3.036	5.408
66– 68..	1.672	4.348	5.975	3.416	4.744	8.160
69– 71..	2.676	4.013	6.689	4.839	5.029	9.868
72– 74..	8.696	9.699	18.395	7.306	7.780	15.086
75– 77..	9.699	6.689	16.388	7.400	7.021	14.421
78– 80..	9.699	8.696	18.395	7.970	4.934	12.904
81– 83..	5.351	4.348	9.699	4.554	2.941	7.495
84– 86..	6.020	1.003	7.023	2.941	2.372	5.313
87– 89..	2.007	0.335	2.342	1.803	0.759	2.562
90– 92..	0.335	0.335	0.670	1.328	0.646	1.974
93– 95..	2.007	0.335	2.342	0.949	0.380	1.329
96– 98..	1.003	—	1.003	0.380	0.380	0.760
99–101..	0.669	—	0.669	0.190	0.190	0.380
102–104..	—	—	—	0.190	—	0.190
105–107..	0.335	—	0.335	—	—	—
108–110..	—	—	—	—	—	—
111–113..	—	—	—	0.095	—	0.095
Total % .	54.774	45.488	99.962	52.754	47.233	99.987
No. fish..	163	136	299	556	498	1054
Depth (m)		120			110–285	
Hook size		7			7	

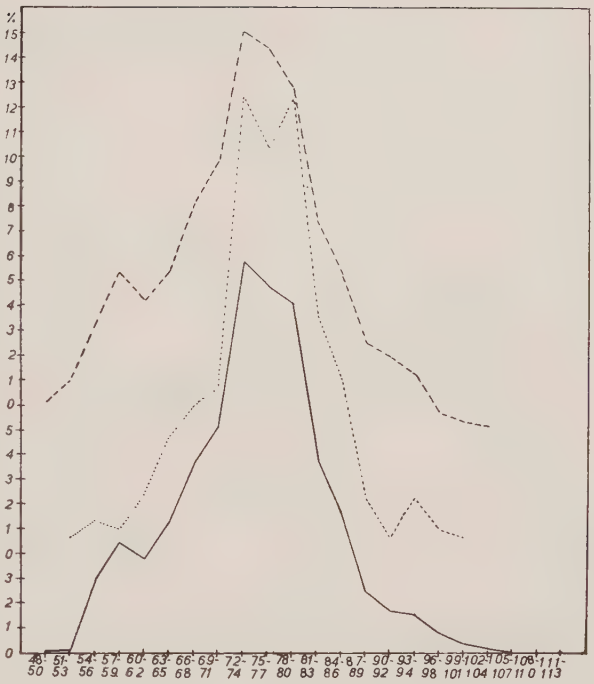


Figure 11. Length composition (in 3 cm length groups) of cod caught on bottom long-lines off West Greenland, 20. June—4. July 1958.
..... = Lille Hellefiske Bank
– – – – – = Fiskenæs Bank/Fylla Bank
——— = Lille Hellefiske Bank + Fiskenæs Bank/Fylla Bank

covered the top of the bank and the upper part of the bank slope in a depth from 25 to about 220 m.

Also on Fylla Bank (Fig. 10), cold arctic water with temperatures of 0—2°C were found on the upper part of the bank slope from about 15—300 m, but here warmer water with temperature of more than 2.5°C was lying on the top of the bank.

In Table 11 we find the registered bottom temperatures where the vessels were fishing, and we also see that satisfactory fishing only took place where the temperature was more than 2°C.

Cod investigations

In 1958, samples of cod caught on bottom long-line only were collected. Altogether 9 samples of cod were obtained from 21. June to 4. July in the area between the southern part of Fiskenæs Bank and the northern part of Lille Hellefiske Bank. A total of 1,353 length measurements and otoliths were collected.

The length frequencies of the cod caught on Lille Hellefiske Bank, Fiskenæs Bank/Fylla Bank and on these banks together are shown in Figure 11 and Table 12.

Table 13. Age frequencies of cod at West Greenland in 1958

Year-class	Age	Lille Hellefiske Bank, July, Bottom long-line			Fiskenæs Bank/Fylla Bank, June, Bottom long-line		
		♀♀	♂♂	Total	♀♀	♂♂	Total
1954	4	0.335	—	0.335	0.095	0.095	0.190
1953	5	2.341	2.007	4.348	5.029	4.744	9.773
1952	6	3.010	1.003	4.013	3.985	3.510	7.495
1951	7	3.010	4.682	7.692	5.313	4.839	10.152
1950	8	8.361	7.358	15.719	11.765	9.867	21.632
1949	9	2.341	1.338	3.679	2.372	1.423	3.795
1948	10	6.355	5.017	11.372	3.890	3.226	7.116
1947	11	18.730	15.050	33.780	12.334	11.860	24.194
1946	12	2.007	3.679	5.686	2.182	2.182	4.364
1945	13	1.672	1.338	3.010	1.898	2.087	3.985
1944	14	1.672	1.003	2.675	1.044	0.569	1.613
1943	15	0.335	1.338	1.673	0.854	1.518	2.372
1942	16	2.341	1.338	3.679	1.233	0.759	1.992
1941	17	1.003	—	1.003	0.474	0.190	0.664
1940	18	0.335	0.335	0.670	0.285	0.285	0.570
1939	19	0.669	—	0.669	—	0.095	0.095
Total %		54.517	45.486	100.003	52.753	47.249	100.002
No. fish		163	136	299	556	498	1054
Depth (m)			120			110–285	
Hook size			7			7	

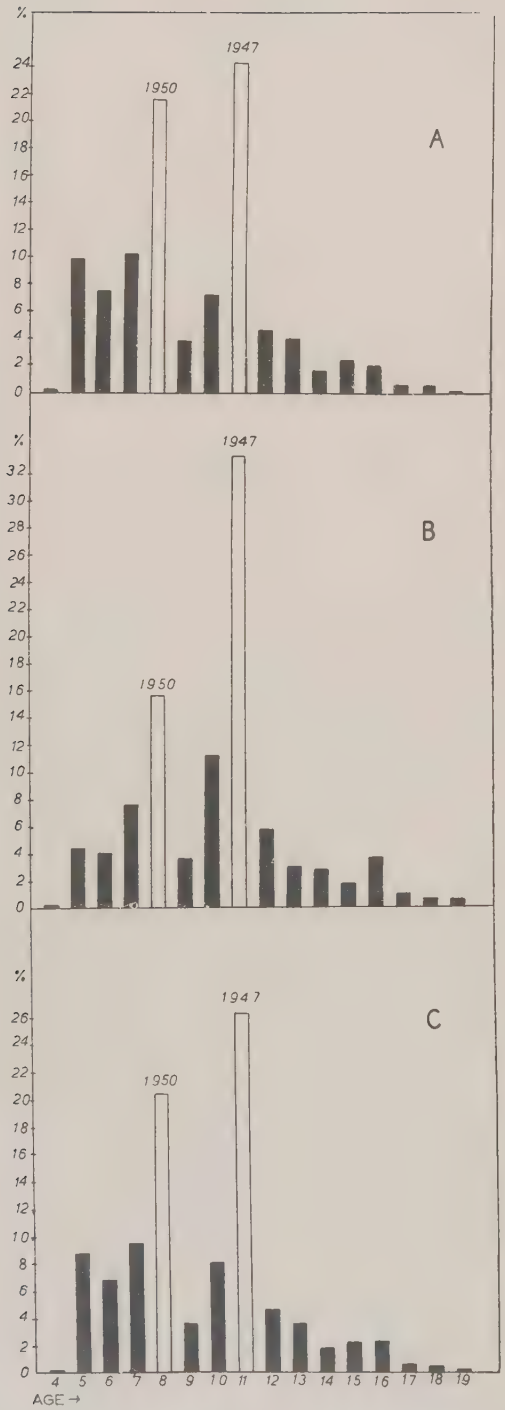


Figure 12. Age composition of cod caught on bottom long-lines off West Greenland, 20. June—4. July 1958.

A = Fiskenæs Bank/Fylla Bank
B = Lille Hellefiske Bank
C = A + B

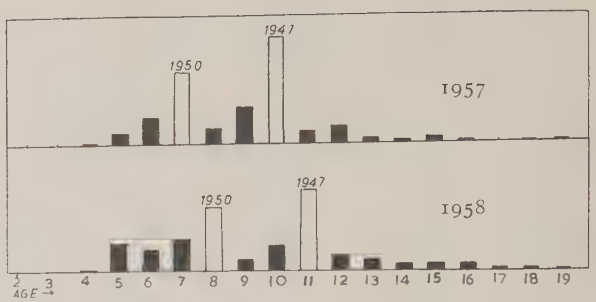


Figure 13. Age composition of cod in Norwegian commercial catches taken off West Greenland in 1957 and 1958.

Compared with 1957, the cod was also in 1958 of good commercial size for the Norwegian vessels. The mean length of the cod on Lille Hellefiske Bank was 73.50 cm, and on Fiskenæs Bank/Fylla Bank 76.20 cm. In all samples the total mean length was 73.57 cm and the mean age 8.85 years.

The age compositions of the samples are shown in Figure 12 and Table 13, and the age composition of the total samples of 1958 compared with the age composition of the total samples of 1957 are shown in Figure 13.

We still find that the 1947 year-class (11 years old) and the 1950 year-class (8 years old) are dominating in the fishery, and the 1947 year-class is still the strongest. The 1947 year-class constitutes 26.31% of all the samples. The total mean length of this year-class in all the samples is 78.34 cm. The same figures for the preceding year were 34% and 76.09 cm. The 1950 year-class constituted in 1958 20.32% of the total catch with a mean length of 72.28 cm. The same figures for this year-class were in 1957 23.4% and 70.29 cm.

The strength of both the 1947 and 1950 year-classes has decreased as compared with the 1957 catch, but it is expected that these two year-classes also will dominate the fishery next year and give catches of good commercial size.

Erling Bratberg

Icelandic Stock

The Spawning Stock of Cod in 1958

(Tables 14–15)

In Table 14 is shown the age distribution of the spawning stock of cod in 1958. The table is based upon samples from long-lines and gill-nets collected during the months January to May on the spawning grounds off the south-west coast of Iceland. The table is calculated in 10,000 as in previous reports. In 1958 the stock was mainly composed of the 1949 and 1950 year-classes, but the strong 1945 year-class had dropped to 11.7% from 28.5% the year

Table 14. Icelandic spawning stock of cod, 1958

Age at first spawning

Age-groups	4	5	6	7	8	9	10	11	12	13	14	Total
4	157	—	—	—	—	—	—	—	—	—	—	157
5	9	134	—	—	—	—	—	—	—	—	—	143
6	—	14	529	—	—	—	—	—	—	—	—	543
7	—	—	110	898	—	—	—	—	—	—	—	1,008
8	—	5	55	198	2,320	—	—	—	—	—	—	2,578
9	—	—	32	198	594	2,472	—	—	—	—	—	3,296
10	—	5	5	23	110	78	198	—	—	—	—	419
11	—	—	5	28	60	134	106	115	—	—	—	448
12	—	—	—	—	14	14	32	23	9	—	—	92
13	—	—	—	18	64	224	336	290	193	23	—	1,168
14	—	—	—	5	5	9	9	28	18	—	—	74
15	—	—	—	9	—	—	—	23	18	5	5	60
16	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	5	—	—	—	—	5
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	5	—	—	5
20	—	—	—	—	—	—	—	5	—	—	—	5
Total	166	158	736	1,377	3,167	2,931	686	484	243	28	5	10,001

Spawning classes

	1	2	3	4	5	6	7	8	9	10	Total
Number	6,855	1,330	842	516	303	83	23	15	9	5	9,981

Table 15. Icelandic spawning stock of cod. Average lengths of the age-groups in 1958 and averages for 1928—1951

Age	1958 cm	1928–1951 cm
3	56.6	51.3
4	66.3	60.9
5	70.5	68.3
6	77.6	75.1
7	82.3	79.2
8	79.0	81.8
9	82.3	85.6
10	86.6	87.3
11	89.3	90.6
12	94.8	93.6
13	97.2	96.8
14	98.8	100.3
15	104.3	102.9

before. This year-class has lasted unusually long because of migrations from Greenland.

The number of first-time spawners is high, compared to the average of 54.7% for the years 1949 to 1958.

In Table 15 are shown the average lengths of the age-groups in 1958 and for comparison the mean average lengths for the age-groups during the period 1928—1951.

Jón Jonssón

Arcto-Norwegian Stock

Soviet Investigations in the Barents Sea

(Figures 14–18; Tables 16–20)

In the second half of 1956 sharp changes took place in the trawling conditions in all regions of the southern part of the Barents Sea (Fig. 14). From June inclusive the mean catch per hour's fishing decreased rapidly on the Murman coast and on the group of central grounds which hitherto had been a region of successful summer fishing. There was nothing to fish for as no cod shoals appeared; the same was the case during the autumn. Some cod and haddock passed along the coast in the south-eastern region, but the density of the fish shoals and the area where they occurred were considerably less than in the corresponding seasons of the previous years.

Figure 15 shows the changes in the mean catch per hour's trawling of Soviet trawlers in the Barents Sea during a long series of years. After a considerable increase reaching a peak in 1955, the curve fell sharply in 1956 and this decline continued until 1958, although less pronounced. On the basis of the data given below some conclusions may be drawn about the reasons for the changes in the fisheries.

Tables 16, 17, and 18 give data for four years (1955/1958) of length composition of cod occurring on the three groups of grounds sited in the southern part of the Barents Sea. Similar changes are apparent in the predominant length groups of the western and central grounds in the period 1955 to 1957, but on the western grounds we find in 1957 a second maximum for the length group 30/35 cm. In the Murman coastal region fish of 35/45 cm length were predominant in 1957. In 1958, the length groups 40/50 cm increased in importance in the western region and on the Murman coast.

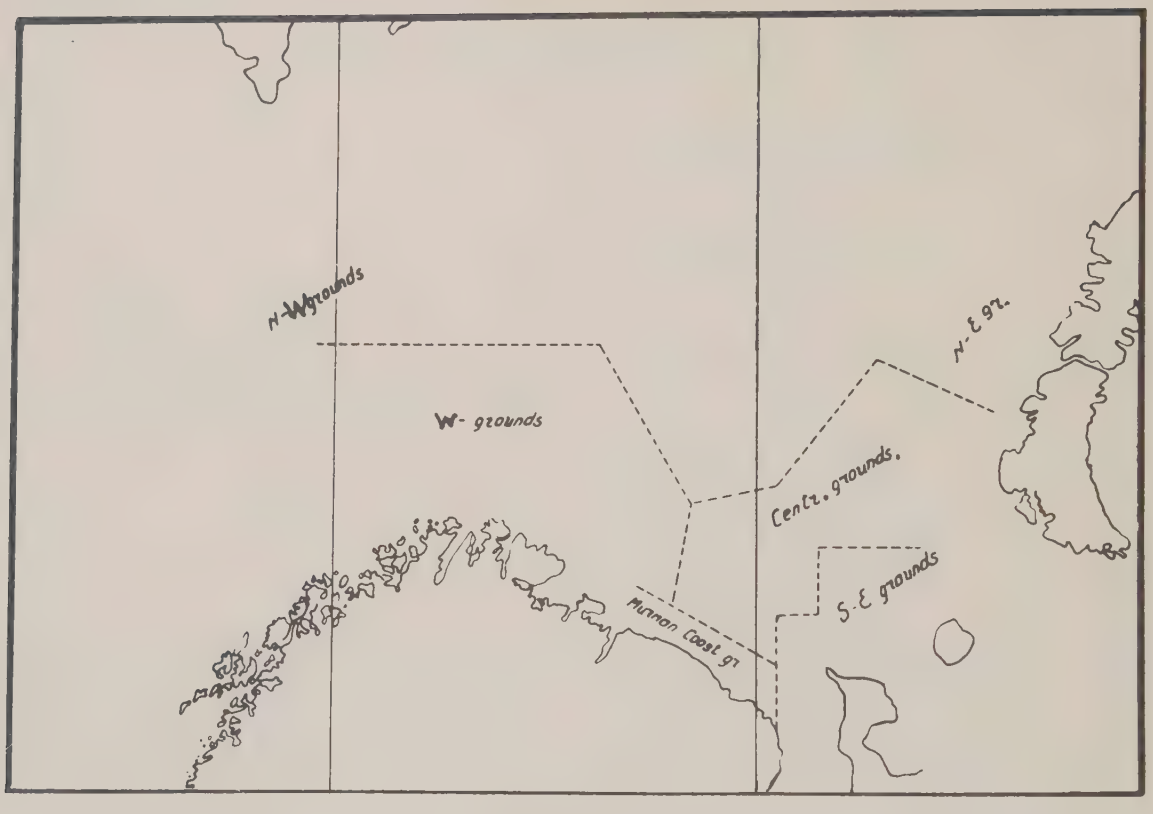


Figure 14. Position of the fishing grounds.

Table 16. Length composition of cod on the western grounds (‰)

cm	1955	1956	1957	1958
10/15	+	4	+	+
15/20	1	1	2	2
20/25	2	3	4	8
25/30	6	11	24	18
30/35	12	21	51	50
35/40	36	36	75	123
40/45	91	74	91	155
45/50	144	124	80	150
50/55	179	166	88	128
55/60	160	166	105	87
60/65	130	141	120	67
65/70	84	99	106	53
70/75	59	60	89	49
75/80	41	36	66	42
80/85	25	23	39	31
85/90	14	19	27	20
90/95	8	9	16	10
95/100	4	4	10	4
>100	3	3	6	3
Number invest. ...	48,792	69,312	50,207	86,758

Table 17. Length composition of cod on the central grounds (‰)

cm	1955	1956	1957	1958
10/15	+	6	+	—
15/20	1	19	1	1
20/25	2	9	3	4
25/30	6	26	82	31
30/35	12	30	79	28
35/40	36	48	73	58
40/45	91	97	67	91
45/50	144	156	77	105
50/55	179	177	92	101
55/60	160	144	127	105
60/65	130	108	132	84
65/70	84	63	100	83
70/75	59	42	65	80
75/80	41	25	41	74
80/85	25	16	23	58
85/90	14	12	15	45
90/95	8	9	10	24
95/100	4	5	6	15
>100	3	4	7	12
Number invest. ...	75,223	52,570	20,654	31,510

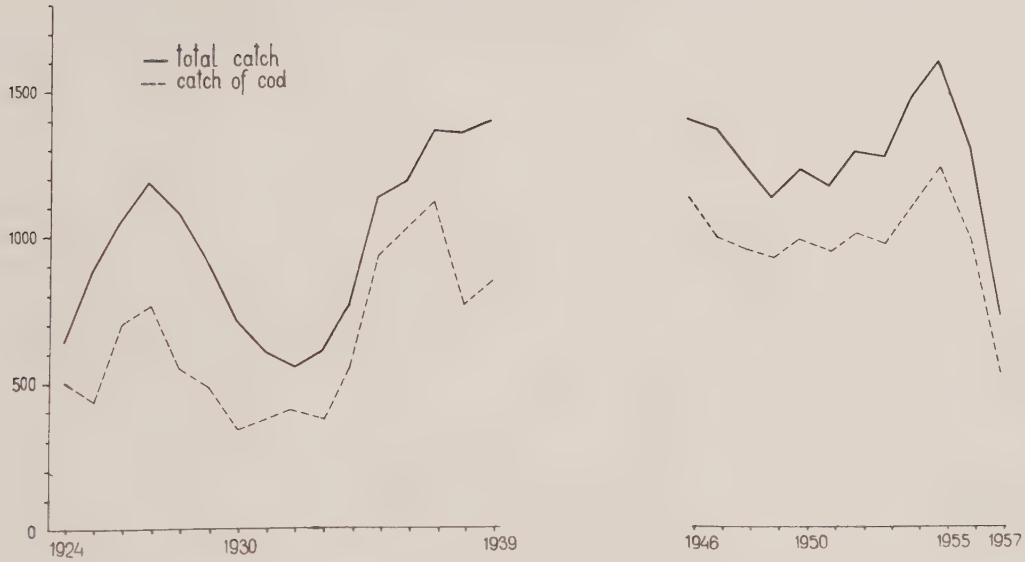


Figure 15. Catches taken per hour in the Barents Sea by Soviet trawlers.

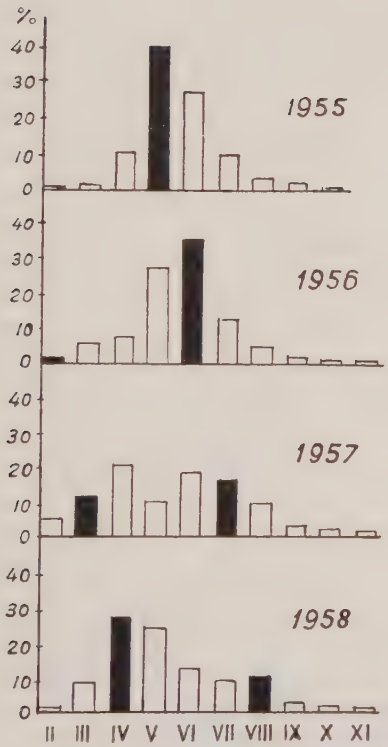


Figure 16. Age composition of cod in the southern part of the Barents Sea.

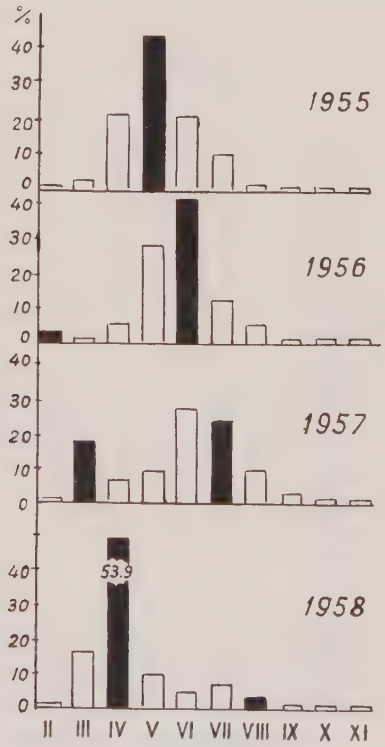


Figure 17. Age composition of cod on the north-western fishing grounds.

Table 18. Length composition of cod on the Murman coast (‰)

cm	1955	1956	1957	1958
10/15	1	2	2	—
15/20	1	2	4	+
20/25	1	2	3	1
25/30	2	6	41	31
30/35	4	11	109	52
35/40	28	30	134	104
40/45	89	66	126	137
45/50	177	105	98	133
50/55	236	131	75	117
55/60	192	151	65	94
60/65	116	151	64	84
65/70	62	131	62	71
70/75	38	82	64	58
75/80	25	56	50	44
80/85	12	34	33	35
85/90	8	19	23	19
90/95	3	9	18	10
95/100	2	3	15	6
> 100	2	2	12	3
Number invest. ...	46,926	31,753	17,320	49,386

Table 19. Length composition of cod in the southern part of the Barents Sea (‰)

cm	1955	1956	1957	1958
10/15	3	3	1	+
15/20	9	8	2	2
20/25	8	5	4	6
25/30	9	15	43	25
30/35	13	22	77	47
35/40	41	39	100	105
40/45	106	80	102	137
45/50	172	131	86	136
50/55	201	163	83	119
55/60	158	155	97	92
60/65	102	132	105	75
65/70	61	93	90	64
70/75	43	58	73	57
75/80	30	37	53	49
80/85	19	23	32	37
85/90	11	16	22	25
90/95	6	9	14	12
95/100	3	4	9	7
> 100	3	3	7	5
Number invest. ...	173,204	153,713	95,006	168,384

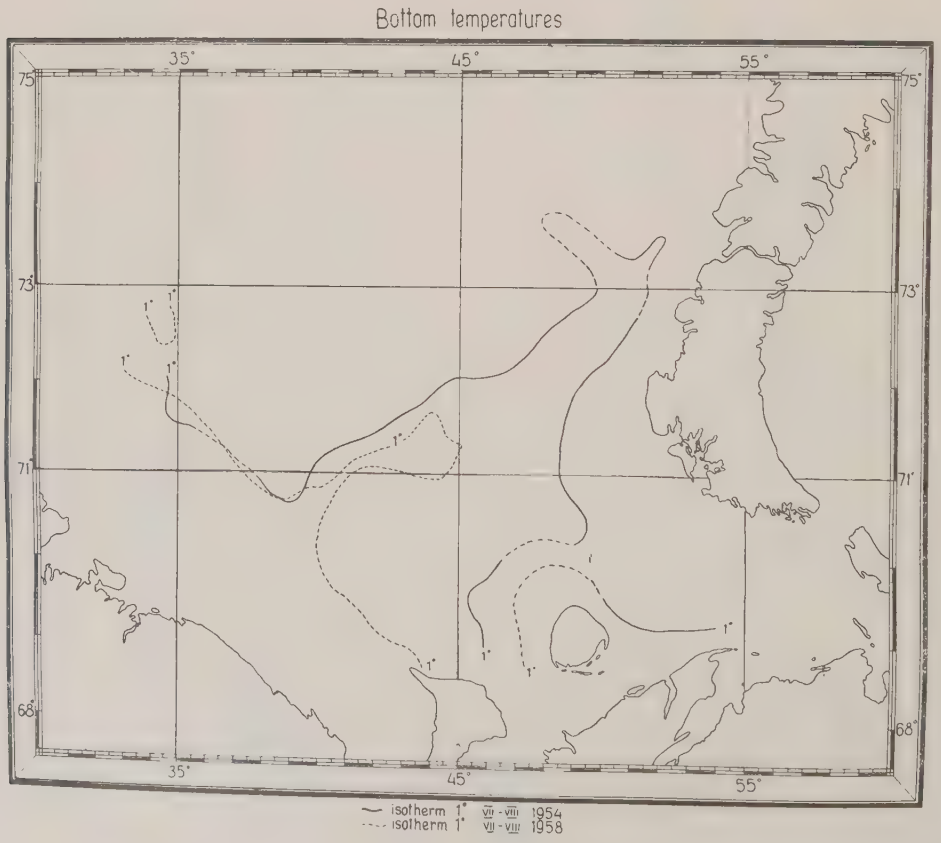


Figure 18. 1° isotherms in the Barents Sea in 1954 and 1958.

Table 20. Length composition of cod on the north-western grounds (‰)

cm	1955	1956	1957	1958
10/15	9	4	1	—
15/20	15	8	3	+
20/25	6	16	13	2
25/30	5	13	31	27
30/35	8	9	37	62
35/40	16	12	61	134
40/45	41	32	64	199
45/50	89	69	56	210
50/55	165	112	66	127
55/60	240	163	97	59
60/65	197	196	123	39
65/70	93	174	136	37
70/75	53	97	124	36
75/80	31	49	92	29
80/85	14	24	50	20
85/90	7	13	23	11
90/95	4	5	10	5
95/100	1	2	6	2
> 100	2	1	7	1
Number invest. ...	122,455	85,979	71,304	130,128

Table 19 gives the length of cod during the same period for the southern part of the Barents Sea. Here it is also apparent that the young fish in 1958 predominated at a length maximum of 40/50 cm. It must, however, be taken into account that in 1957/58 the trawlers were mainly fishing on the western grounds; in the central and coastal regions the fish were scarce during all seasons.

Table 20 shows the length of cod in the north-western Barents Sea (Bear Island, Spitsbergen, and Hope Island banks). It appears clearly from the table that in these regions the larger cod were replaced in 1958 by fish of 40/50 cm length (35/55 cm).

Figures 16 and 17 show the age composition of cod for the same four years in the southern and north-western parts of the sea; (age readings made by E. M. Mankevich). The results of the length measurements show clearly that the 1950 year-class is decreasing. In 1957 this decline was more noticeable in the southern than in the north-western part of the sea. In 1958 the following year-classes were predominant: north-western region, the 1954 year-class; southern region, the 1954 and 1953 year-classes; the importance of the latter was particularly great for the Norwegian spring fishery at Finnmarken.

Figure 18 shows the 1° isotherm for August/September according to observations made in 1954 and 1958; (chart drawn up by R.N. Sarynyna). The changes in locality of these isotherms are remarkable. The year 1954 was very warm in a hydrological sense, and the bottom areas of the eastern part of the sea having a water temperature above 1°C were stretched far to the east and north-east. In the same season in 1958, however, the 1° isotherm was lying far to the west. Practicâlly almost the entire space of the central and north-eastern regions, which in other years were very important fishing areas, is occupied by water with bottom-layer temperatures below 1°C. This fall in temperature in the eastern part of the sea became apparent in the summer of 1956.

N. A. Maslov

Baltic Stock

German Investigations in the Western Baltic

(Tables 21–22)

Trawling experiments were continued by R/V "Hermann Wattenberg" on various fishing grounds in the Kiel Bay and the waters round Fehmarn during January, March, July, and October 1958. The results for cod are shown in Table 21.

In 24 trawling hours 1,455 cod were caught, i.e., 61 fish per hour. In the preceding year (April—June 1957), the number of cod per hour's fishing was similar (68). Two years ago, in May—June 1956 only half of this amount (31) was caught.

Compared with the results in the preceding years, the frequency of the youngest age-groups 0 and I has increased and the number of older and marketable fish has decreased, as shown in Table 22.

Table 21. Length distribution of cod in hauls with the standard trawl in the western Baltic in 1958

Month	Number of stations	Total number of fish caught	Number per hour's fishing 5 cm groups 6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	> 60	Total
Jan./March	6	468	8	23	17	2	1	0.2	0.1	0.2	—	0.3	0.2	0.2	52
July	11	511	1	16	10	5	1	3	4	3	2	3	2	1	51
October	7	477	27	19	10	19	10	3	2	2	0.6	1	0.8	—	95

Table 22. Number of cod of the different age-groups taken per hour with the standard trawl in the western Baltic

Date	Number of stations	Age-group 0	I	II	III	IV	V+	Total
April/June 1956	14	—	10.6	7.7	5.8	2.9	3.8	31
October 1956	13	30.0	36.4	23.4	7.3	2.0	0.9	100
April/June 1957	23	—	12.0	29.5	22.0	3.9	1.0	68
January/March 1958	6	49.2	1.8	0.3	0.5	0.1	0.1	52
July 1958	11	1.0	31.6	9.4	5.2	3.8	0.1	51
October 1958	7	46.2	42.0	4.8	1.2	1.2	—	95

The 1956 year-class seems to be less frequent than the 1955 year-class. The breeding seasons of 1957 and 1958 have provided a fairly good supply of young fish which remarkably contrasts to the low frequency of cod eggs found in these years in the western Baltic (see p. 79).

R. Kändler

Danish Investigations on Cod in the Bornholm Region

(Tables 23–25)

The stock of cod was investigated on the basis of 14 hauls in August 1957 and 16 hauls in 1958, all made with the standard trawl. The length composition round Bornholm from 13°—15°40′E is shown in Table 23 and the age in Table 24.

Table 23. Length distribution (‰) of cod in Danish catches in the Bornholm region

(The lengths measured to the nearest lower whole cm)

cm	1951–56	1957	1958
5–9	55	346	8
10–14	73	160	145
15–19	229	1	295
20–24	161	30	169
25–29	138	112	47
30–34	116	147	42
35–39	86	94	78
40–44	61	57	92
45–49	39	35	68
50–54	23	10	35
55–59	10	2	9
60–64	4	2	6
65–69	4	2	3
70–74	—	1	1
75–79	—	0.4	1
Total	999	999	999

The 1957 year-class was very numerous. The trawl had an 18 mm cod-end (knot to knot) and a great portion of the cod less than 10 cm in length therefore escaped through the meshes in 1957. The 1956 year-class was poor which must no doubt be attributed to the cold summer and the scarcity of plankton in 1956.

Table 24. Numbers per 5 hours' haul with the standard trawl (preliminary figures) in Danish catches in the Bornholm region

Age-group.	0	I	II	III	IV	V	VI	VII+	Total
1957	195	1	70	78	35	3	1	0.3	383
1958	5	1005	60	170	70	2	1	1	1,314

The length of the age-groups was as follows. The number investigated is shown in brackets (preliminary figures).

Age-group	1950–56 cm	1957 cm	1958 cm
I	—	—	7.9 (3,213)
II	26.8	28.4 (425)	27.1 (195)
III	35.3	33.9 (410)	40.6 (539)
IV	46.5	43.7 (191)	48.2 (220)

The length of the II-group in 1957 seems to have been a little greater than the mean length in previous years, while the length of the III- and IV-groups seems a little less. In 1958 the length of the II-group was about the average for 1950—56. In 1958 the length of the III- and IV-groups exceeded that of the previous years, which may indicate some error in the age determination.

Tagging experiments in the Baltic

Cod have been tagged east of Bornholm in 1957, 1958, and 1959. This is a preliminary report on some of the results of the taggings in the first two years.

In 1957 and 1958 the alcathene plastic tags were fastened with full nylon thread 0.3 mm thick; in 1957 the thread was carefully twined of two single threads into a relatively stiff thread. In 1958 the twine was loose and the thread very flexible and therefore the sharp single threads might cut into the flesh of the fish.

The Lea tags were fastened by a loop of steel. The button marks were made of ebonite connected with a silver thread and fastened in the gill cover.

Table 25. Number of cod marked with the different types of tags and number and percentage recaptured

	Number tagged	Number recaptured in months after tagging							Percentage recaptured	
		1	2	3–4	5–8	9–12	13–18	19–24	First year	Second year
19.–26. March 1957										
Blue alcathene	49	2	1	1	—	—	2	1	8	6
Red alcathene	99	8	8	1	6	3	2	1	26	3
Button	86	11	3	3	2	—	—	—	20	0
7.–13. March 1958										
Red alcathene	291	15	8	1	6	3	2	?	11	?
Lea	109	12	4	2	6	4	—	?	26	?

It may seem that the value of the blue plastic tags was very much inferior to that of the red; undoubtedly the former are less visible.

In 1958 the red plastic tags gave lower recoveries than those in 1957 which may be due to the loose twining in 1958.

The cod were fished in 20—30 minute hauls, and the fish in the trawl were emptied out in a tub of about 1 m diameter filled with water to a height of 60 cm, which water was renewed from the pump. The cod which turned the belly up or were very damaged were immediately removed. Only those which seemed not to be vitally damaged were used for tagging, but on some of these the scales were more or less abraded by the trawl, and a few of them had white marks of scratching or reddish flanks or heads. A number of these fish were used for tagging in order to try if they were less fit for marking experiments than those which were not visibly damaged.

The number of cod with abraded scales, scratching or other apparently small damages were as follows:—

1957: 11, of these were 0 recaptured
1958: 53, of these were 5 recaptured

The percentage of recaptures of the damaged fish is much less than that of the undamaged, and the percentages of recaptures, shown in Table 25, which are calculated without taking any account of this source of error, are lower than the actual fishing mortality.

If a cod by accident had been dropped on the deck it was not used for marking.

On a few cod the needle used for marking hit a blood-vessel; three of these fish, where the bleeding was not strong, were released; none of them were recaptured but naturally this may be accidental. Three of the fish released in 1957 and 4 in 1958 turned the belly up when released and could not swim down. None of these have been recaptured and have been cancelled from the list of tagged cod.

When we calculate the percentage of recoveries without the fish visibly damaged (abraded scales and similar damage), the recapture in the first year for those with red plastic tags was 29% in 1957, and for those with the Lea tag 30% in 1958.

The percentages of recaptures are higher for cod between 40 and 60 cm than for cod under and over this limit as is seen from the following recapture figures(%). (Number of cod tagged in brackets):—

	1957		1958 Plastic		1958 Lea	
cm						
20–29	18	(4)	9	(1)	22	(1)
30–39		(35)		(75)		(54)
40–49	26	(86)	14	(129)	30	(50)
50–59	33	(67)	11	(70)		(3)
60–69	11	(24)	8	(11)		
70–79		(3)		(1)		

The group of less than 40 cm length comprises very few fish below the size limit for cod caught commercially in the different Baltic countries, and the inclusion of these in the table cannot affect the recapture percentages to any perceptible degree. The tagging mortality must be greater for the cod under 40 cm than for larger cod. On the other hand, the small recapture percentages of the largest cod can hardly be due to a relatively great tagging mortality, and so far the natural mortality may not seem to be higher for fish with lengths between 60 and 70 cm than for those between 40 and 60 cm. The cause of the lower percentage of recapture must therefore be searched for in a lesser fishing mortality. Perhaps these large cod have a greater ability of avoiding the trawl on account of their greater swimming power. We do not know if the larger cod have other biological habitats than the smaller, e.g., more preference for stony bottom, which may decrease their percentage of recapture. A more essential source of error is that relatively very few cod have been recaptured when they had been in the tub for about an hour or more, although they apparently behaved just as vitally as those marked immediately after capture. This was especially the case in 1958.

Thus in some markings with red plastic tags the following recaptures were obtained in three cases of relatively large catches of cod:—

First year		Second year	
Tagged	Recaptured	Tagged	Recaptured
36	7	31	1
26	7	23	0
36	8	56	2

It seems to be very important for the result that the cod are tagged very soon after capture. Possibly the natural conditions were especially unfavourable in 1958 because the temperature of the air was mostly below zero and the cold surface water may therefore have damaged the gills of the fish.

Undoubtedly the annual fishing mortality is less in the Bornholm region than for instance in the Belts or the western Baltic, but it must be considerably greater than the percentage of recaptures in the first year. At Bornholm the total annual reduction of the number of a year-class older than the III-group is nearly 80%, as found from age analyses of the stock, and 73% from the recaptures in the first and second year; in a previous paper I have judged the natural mortality to account for 30% or a little less. The percentage of recaptures in the first year should therefore be 45 or 50 instead of the 30% found here. The emigration from the area is of no practical importance.

Possibly a great part of the recaptured cod is not reported, but the relative numbers of the tags from the different countries fishing in the area do not seem to indicate a serious lapse in the recording of recaptured cod. The distribution of the different countries is as follows for the taggings in 1957 and 1958. It is almost the same in both years:—

	%
Denmark	34
Germany (Democratic Replublic)	12
Germany (Federal Republic)	18
Poland	16
Sweden	19
USSR	1
Total	100

From USSR only one recapture is recorded, e.g., off Klaipeda (Memel) in about 55°40′N and 20°40′E, but it is natural that the recaptures from USSR fishermen are less than those from the others because they mainly fish to the east of 17°E.

If a relatively great part of the cod migrated to the waters east of 17°E we might expect recaptures recorded especially from Polish fishermen who to a great extent fish to the east of this line, and also from Swedish fishermen in the Öland-Gothland region, because these fishermen have recorded many from the regions where most of the cod are recaptured. Actually we have only one Polish recapture east of 16°40′E, namely from 17°40′E.

Most of the cod have been recaptured within 50 miles of the tagging locality. Naturally this is influenced by the fact that more than half of all recaptures take place in the first two months after tagging, and that the tagging has been carried out near the spawning place of the Bornholm basin, where the cod have accumulated for the spawning which takes place one or two months later.

Yet one cod of the 117 recaptured had migrated from 5 miles NE of Christiansø to the Kalmar Sound in the course of 22 days, and in the first and second month five were recaptured on the Slupsk bank. That is, the fish had travelled about 60 miles. In the second month after tagging two of the cod marked at Christiansø were taken in the Møen region and one near the Oder estuary. These migrations were of about 90 miles.

Five cod were recaptured about one or two years after the tagging, i.e., 11—13 or 23—25 months after. Three of them were taken within about 10 miles from the tagging locality, one at a distance of about 40 miles, and one about 160 miles away. This material is too small but may indicate that a relatively great part of the stock returns to the same spawning ground the next year. In the 4th — 10th month or 16th — 22nd month after tagging the recaptures have, on the whole, shown longer migrations. The recaptures have been found nearly in all directions except the bay between Scania and Blekinge to the north-west of Christiansø, which undoubtedly is due to less fishing activity in this region. Of the 117 recaptured fish 5 or about 4% were taken in the Baltic proper east of Bornholm. Very long migrations have been undertaken by two cod, one was recaptured in the 11th month at the southern entrance to the Great Belt about 160 miles from the place of marking, and the other in the 6th month off Klaipeda, a migration in a straight line of 180 miles.

From the migrations stated by the marking experiments a considerable intermixture seems to take place between the cod in the different parts of the Baltic proper, and this is one of the facts which justify a common minimum size limit for the cod, as recommended by the special meeting for protection of the stocks in the Baltic (see Rapp. Cons. Explor. Mer, 147).

Aage J. C. Jensen

Cod of the Central Baltic in 1958

(Tables 26–29)

Progressive freshening of the bottom waters of the Baltic and deterioration of oxygen on the cod spawning grounds were observed in 1958.

As the analysis of the operations of Soviet trawlers has shown, fish were almost completely absent from the Deep of Gothland and thus the fisheries were carried out mostly above 100 m depth, whereas in 1957 cod fishing was operated mainly at depths below 100 m. The content of dissolved oxygen in the 113 m layer dropped in 1958 to 0.52 cm^3/litre, a content which is deficient not only for the development of eggs but also for the normal existence of adult fish. In the spring a number of cod stayed within the areas of stony and well aerated grounds to the west and east of Gothland Deep, grounds which are not fit for trawling if the trawl is not equipped with bobbins.

Catches of cod on the flat sections of the slope were irregular and varied from 20—100 kg to 800—1000 kg per haul. These variations were probably caused, besides environmental factors, by the fact that spawning and feeding cod were following shoals of sprat in April/May. Such an intensive feeding of cod on sprat in spring has not been observed in previous years.

As can be seen from Table 26 the proportion of sprat eaten by cod in the spring of 1957 was much lower than that in 1958.

In 1958, Baltic sprat increased in numbers owing, firstly, to the entry of three year-old recruits of an abundant 1955 year-class and, secondly, to recruitment by the 1957 year-class. Catches of sprat in the southern Baltic reached 4 tons per 30 min. trawling. In late March 1958, pre-spawning and spawning sprat shoals commenced their spawning migrations from the coastal areas of the Bay of Gdańsk towards greater depths (50—90 m). At that time the cod kept at a depth of 80—90 m, and they fed chiefly on sprat.

Sprat, however, decreased in numbers at depths exceeding 100 m and therefore the proportion of sprat in the stomach content of cod fell from 74.8% at depths of 50—90 m, to 38.4% at 98 m depth.

In the Gothland Deep region concentrations of sprat were scarcer and, consequently, the percentage of cod with empty stomachs increased to 76.7%, although sprat still remained the main food of cod, as it was in the Gdańsk Bay.

It may be supposed that the bulk of the rich 1955 year-class of sprat have attained sexual maturity in 1958, and thus far greater numbers of this year-class stayed on the spawning grounds in the open parts of the Baltic than in 1957 affecting the behaviour and distribution of the cod.

Unfavourable environmental conditions prevailing at that time in the bottom layers of the Gothland and Gdańsk Deeps have compelled the cod to migrate to the western part of the Baltic. This is confirmed both by the results of tagging experiments carried out on cod by Polish workers and by comparison of mean catches per hour's trawling in separate fishing areas. Therefore, in spite of satisfactory stock conditions the average catches of cod per hour's trawling have decreased somewhat, in comparison with 1957, in the whole area where Soviet fishing operations are carried out. This is shown in Table 27.

Table 28 shows that the 1957 year-class (1+ year-old, 20—30 cm long) was predominant in the compositions of the experimental catches taken with small-mesh trawls.

Table 27. Average catches of cod (kg/hour/trawling) by months

(Based on data from the Trawling Fleet Administration in Klaipeda)

	Jan.	Feb.	Mar.	Apr.	May	June
1957	98	150	176	177	142	133
1958	98	135	139	130	134	61

Table 26. Percentage composition of the food of cod in April 1957 and 1958, by areas and depths

(After G. I. Tokareva and G. B. Grauman)

Area	Depth, m	Date, April	Number of stomachs examined	Composition of food in %					% of stomachs	
				Sprat	*Mes.entomon*	Mysidaceae	Amphipodae	Polychaeta	with food	empty
Bay of Gdańsk	50–90	15.1957	50	32.8	41.6	22.7	2.9	—	61.7	38.3
	50–90	1.1958	50	74.8	23.0	—	2.2	—	88.0	12.0
	104–108	15.1957	46	25.4	21.2	17.0	12.8	—	48.8	51.2
	98	9.1958	75	38.4	4.3	—	—	58.3	60.0	40.0
Gotland Deep	112	23.1957	100	36.3	30.6	6.3	26.8	—	33.7	66.3
	100	10.1958	62	87.7	—	—	—	12.3	24.3	76.7

Table 28. Total length of cod in catches taken in October in the Pionersk area by 27 m trawl with 12 mm mesh in cod-end

	Length, cm				
‰	10–14	15–19	20–24	25–29	30–34
	4.7	17.0	31.5	26.8	7.6
‰	35–39	40–44	45–49	50–54	55–59
	2.2	2.9	3.5	2.7	1.1

Table 29. Percentage age composition of cod in the period 1956 to 1958

	Age (years)								
Year	2	3	4	5	6	7	8	9	Total
1956	5.3	34.0	30.0	17.2	9.5	2.4	1.2	0.4	100
1957	3.7	38.0	42.3	12.0	3.0	1.0	—	—	100
1958	0.3	27.5	46.1	20.5	3.3	2.2	0.1	—	100

The 1957 year-class will undoubtedly also be prominent in the commercial fisheries and thus necessitating protection against over-exploitation, especially in view of the fact that both the preceding (1956) and the subsequent (1958) year-classes are poor, evidenced by data showing the results of spawning, quantitative estimation of young fish, and the relatively poor recruitment of 3 year-old cod, which latter fact had been expected.

Therefore, the age composition of the cod confirms that the stock conditions were healthy in 1958, although the unfavourable environmental conditions adversed the formation of dense concentrations of cod on the fishing grounds.

T. Dementjeva, G. Tokareva

Polish Tagging Experiments in the Southern Baltic

(Figures 19–22; Tables 30–31)

In 1957 and 1958, 2,973 cod were tagged in three main areas of the southern Baltic, viz., Gdansk Deep and Bay, Slupsk Furrow, and Bornholm Deep.

The taggings were mainly carried out in the winter/spring season and in autumn.

Two types of tags were applied, viz., red plastic tags and silver disks. The results of tagging with the two different types of tags are given in Table 31.

Migrations

Tagging experiments carried out during 1957 in *Gdansk Deep and Bay* (Fig. 19) show that the migrations of the cod were of rather local character. In 1958, however, an explicit tendency to migrate towards the west, i.e., to the Bornholm Basin, was observed. The same was confirmed by the experiments in 1958/59 (Fig. 20).

Table 31.

Year	Red plastic tags		Silver disks	
	Tagged	Recovered, %	Tagged	Recovered, %
1957	215	9.3	1,280	5.9
1958	1,028	9.2	450	2.4

It is a characteristic phenomenon that mass migrations of cod in western directions are always observed during the spawning period (mainly in spring). In autumn the recoveries generally come from the north-eastern areas of Gdansk Deep, indicating feeding migrations. The mass migrations in spring to the western areas are probably connected with the decrease in salinity of the near-bottom layers in Gdansk Deep.

Although a certain number of fish tagged in the *Slupsk Furrow* area during the period 1957/58 has been caught in Gdansk Deep, the main migration direction is a western one (Fig. 21).

The time the recoveries were made and the maturity stage of the fish give evidence for concluding that these migrations are for spawning purposes. In 1957, when the salinity in Gdansk Deep was sufficiently high some of the fish which had been tagged in the Slupsk Furrow were caught a few weeks later in Gdansk Deep. This may possibly mean that a part of the Slupsk Furrow stock of cod migrates to spawn in the deeper waters of the Gdansk region. But in 1958 no fish tagged in the Slupsk Furrow was recovered in Gdansk Deep during the spawning period; in the feeding period, however, such migrations were observed.

The cod tagged in the southern part of *Bornholm Deep* in 1957 (Fig. 22) had shown migrations of a rather local character. In 1957, only two fishes were caught on the Slupsk Furrow fishing grounds. In the autumn of 1957 and 1958, i.e., during the feeding period, two cod were recaptured in Gdansk Deep.

J. Netzel

Table 30. Taggings and recoveries

Year	Gdansk Deep and Bay		Slupsk Furrow		Bornholm Deep		Total	
	Tagged	Recovered, %	Tagged	Recovered, %	Tagged	Recovered, %	Tagged	Recovered, %
1957	968	4.6	248	9.6	279	8.9	1,495	6.4
1958	1,376	6.6	102	13.7	—	—	1,478	7.1

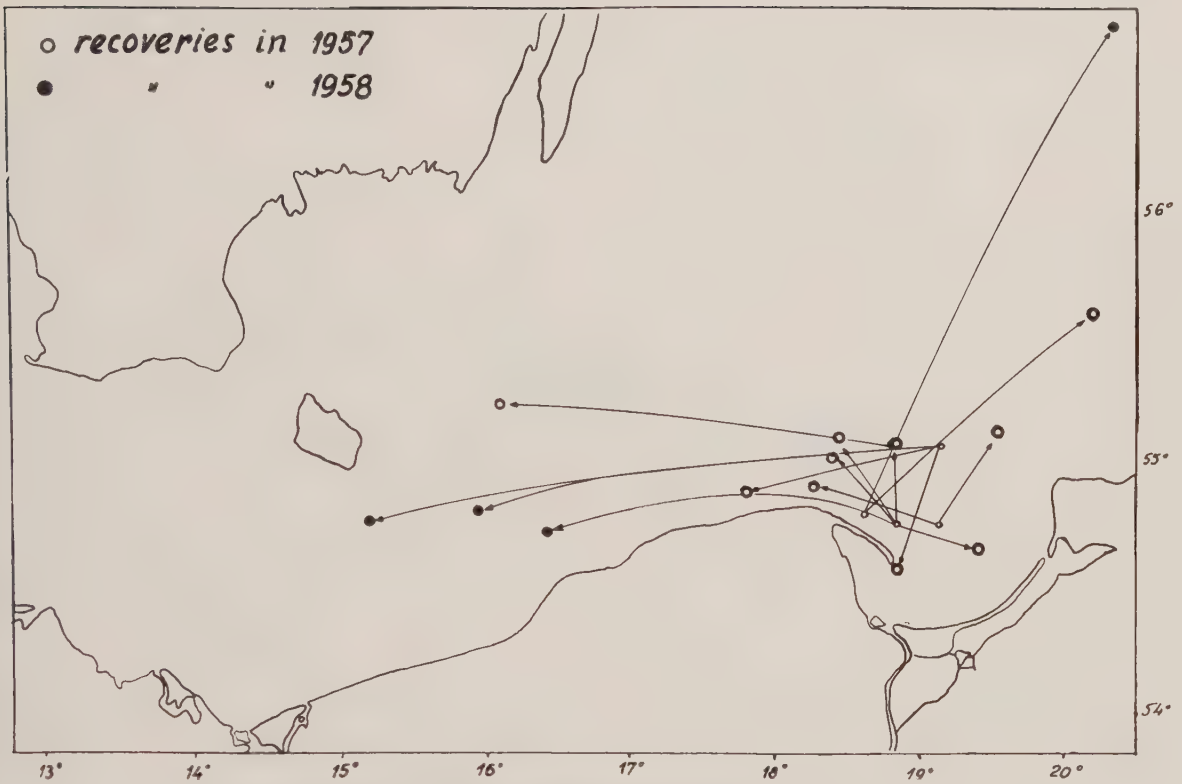


Figure 19. Polish cod tagging in Gdansk Deep in 1957.

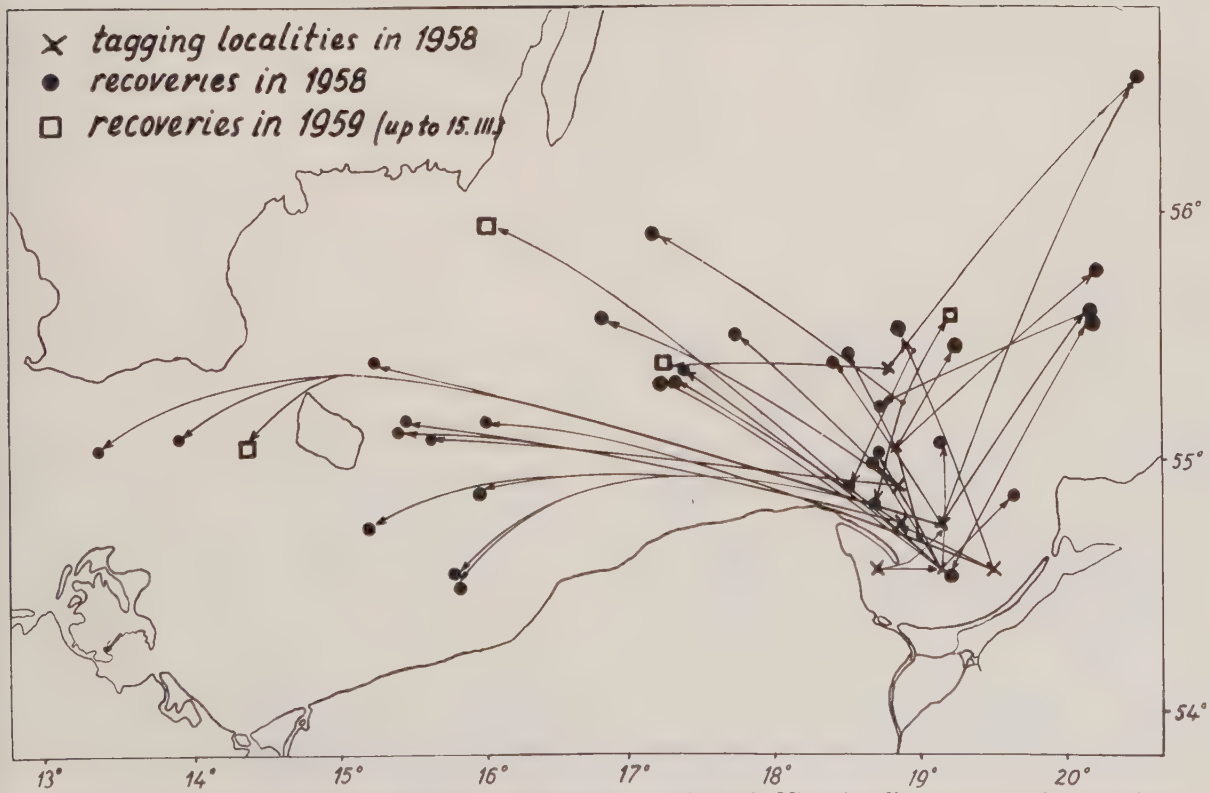


Figure 20. Polish tagging experiments in the south-eastern Baltic in 1958. Migration distances more than 20 miles.

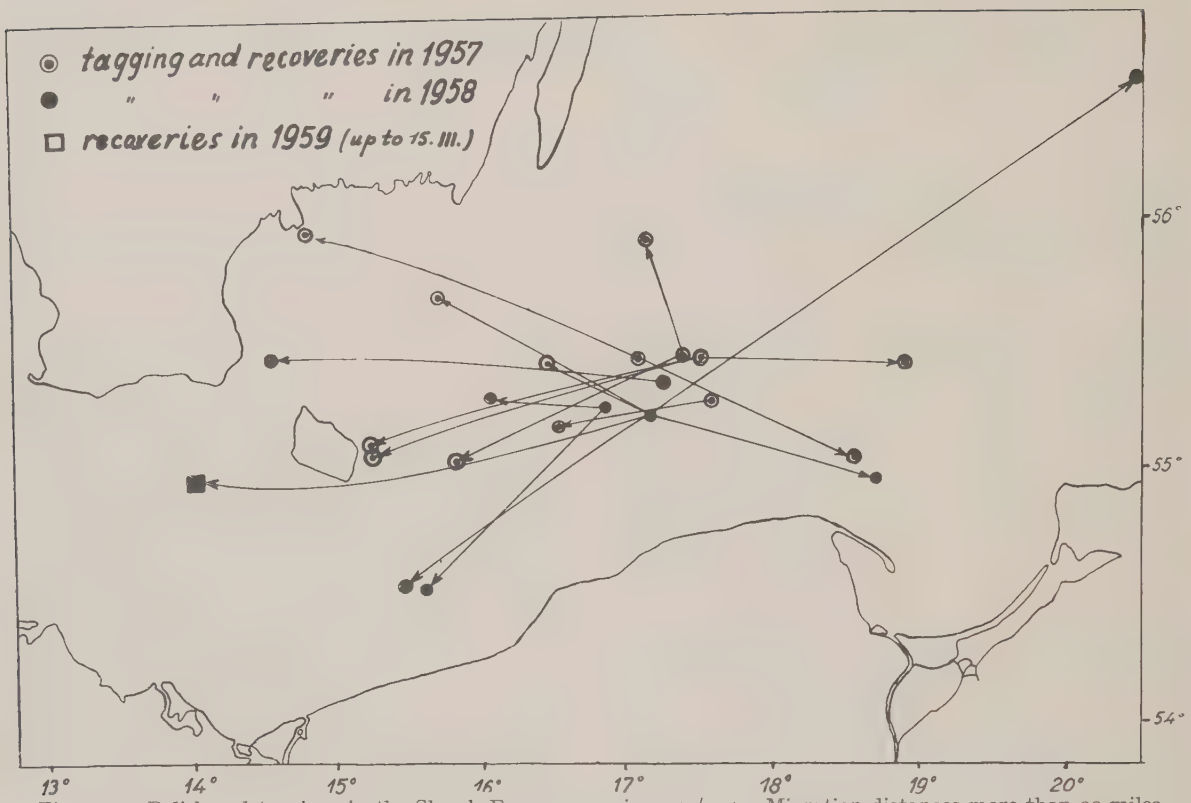


Figure 21. Polish cod taggings in the Slupsk Furrow area in 1957/1959. Migration distances more than 20 miles.

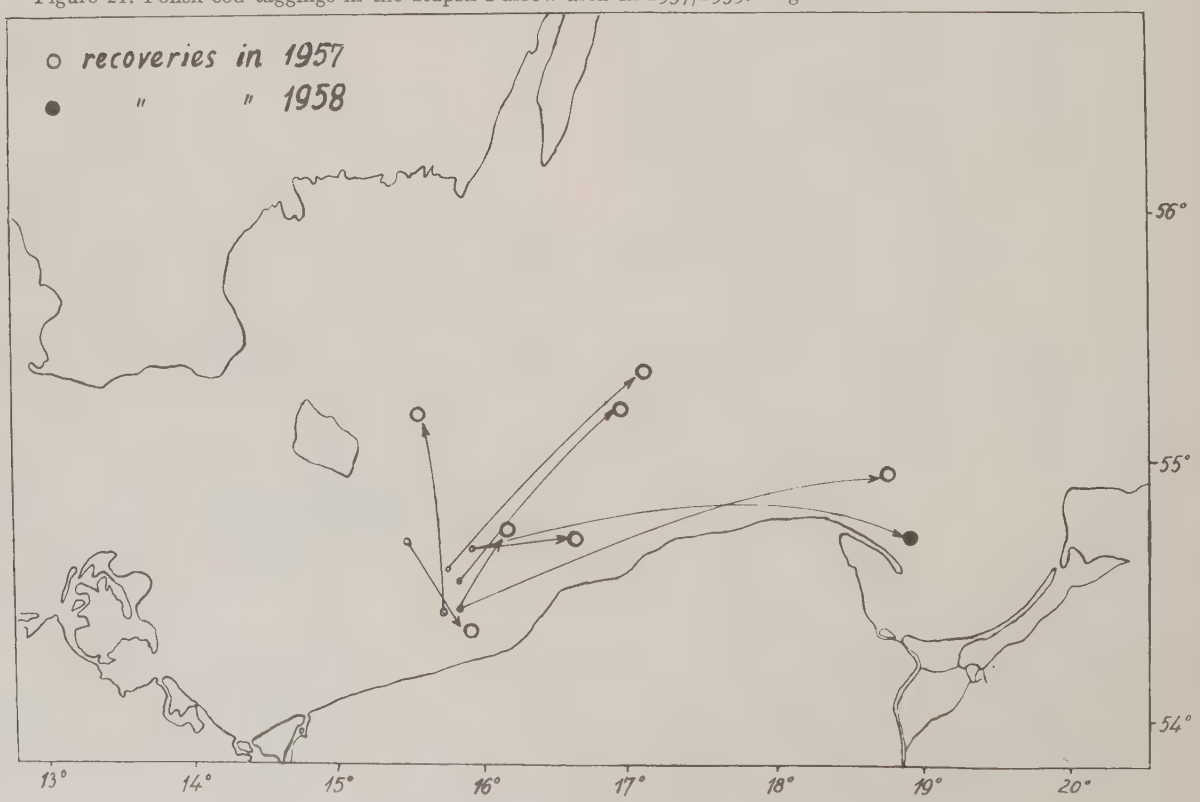


Figure 22. Polish cod taggings in Bornholm Deep (southern area) in 1957.

Table 32.

Region	Months I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
Gdansk Bay	15.2	66.4	10.7	27.1	13.9	21.0	10.2	—	14.7	26.4	18.2	12.3	20.3
Southern slopes of Bornholm Deep	5.8	4.8	8.8	12.7	46.0	10.8	64.0	24.3	13.3	10.8	23.8	17.2	20.2

Investigations on the Food of the Baltic Cod

(Table 32)

In 1958, investigations on the qualitiative and quantitative food composition of the Baltic cod were continued. The fish were caught in Gdansk Bay and on the southern slopes of Bornholm Deep.

Stomach contents of 1212 fish were analysed and determined. Out of this number 852 fish belonged to the Gdansk region and 360 to the Bornholm region.

It was observed that a considerable proportion of the fish had empty stomachs. This condition was observed in 37.2% of the fish belonging to the Gdansk region and in 19.7% of those from the slopes of Bornholm Deep.

From the stomachs of the cod caught in Gdansk Bay 17.33 kg of food of various character have been analysed. The percentage composition was as follows:—

Fish	%	Invertebrates	%
Clupea harengus	19.48	*Mesidotea entomon*	14.25
Clupea sprattus	39.04	*Mysis* sp.	0.94
Clupeidae (not ident.)	10.58	*Gammarus* sp. ...	1.08
Gadus callarias	5.19	*Harmothoë sarsii* .	2.62
Gobius sp.	0.48	Not identified ...	6.34
Total	74.77	Total	25.23

From the stomachs of the cod caught on the southern slopes of Bornholm Deep 7.27 kg of food were analysed. The percentage composition was as follows:—

Fish	%	Invertebrates	%
Clupea harengus	26.83	*Mesidotea entomon*	10.90
Clupea sprattus	27.37	*Mysis* sp.	7.12
Clupeidae (not ident.)	1.62	*Pontoporeia* sp. ..	5.03
Gadus callarias	2.68	*Gammarus* sp. ...	0.30
Onos cimbrius	8.94	*Nereis* sp.	2.18
Total	67.45	Not identified ...	7.02
		Total	32.55

The average weight (in g) of the food contained in the stomach of one cod (empty stomachs included) in the different months of 1958 is given in Table 32.

The total length, weight, age, and sexual maturity of the fish were taken into consideration when the samples were analysed and the results worked up.

K. Strzyzewska

HADDOCK

Arcto-Norwegian Stock

Soviet Haddock Investigations

(Figure 23; Tables 33–36)

In 1958, as in previous years, the Polar Institute made observations on board research vessels and commercial trawlers cruising in different parts of the Barents Sea. The investigations included measurements of the samples and collection of otoliths for age determination. The age composition of the stock has been determined according to the length distribution.

Tables 33, 34, and 35 show the length distribution of the haddock taken on the fishing grounds during the four years beginning with 1955. Table 33 shows the length distribution on the western grounds (see chart, Fig. 14, p. 100). In 1955 and 1956 we find the greatest number of fish in the length groups 40/45 and 45/50 cm; in 1957, however, two groups are also predominant, viz., the 50/55 cm group and the group of younger fish with a length range of 35/40 cm. In 1958 the most numerous groups were those with a length range of 40/50 cm and 20/30 cm.

The length distribution of haddock taken on the Murman coast grounds (Table 34) is also similar for the first two years and resembles the corresponding data for the western grounds. There is, however, only one maximum in this case, the 35/45 length range.

On the central grounds (Table 35) there are two maxima in 1956, viz., the 40/45 and the 30/35 cm groups. In 1957 we find the maxima in the length

Table 33. Length distribution of haddock on the western grounds (‰)

Length, cm	1955	1956	1957	1958
10/15	9	1	1	3
15/20	31	22	8	48
20/25	62	24	13	130
25/30	62	68	35	118
30/35	62	92	96	66
35/40	147	98	161	86
40/45	269	211	181	127
45/50	218	254	190	131
50/55	82	145	219	114
55/60	34	53	114	100
60/65	13	14	31	51
65/70	6	6	12	18
70/75	2	2	5	4
75/80	1	1	3	2
> 80	1	—	3	2
Total	24,665	52,955	49,492	22,486

Table 34. Length distribution of haddock on the coastal grounds (‰)

Length, cm	1955	1956	1957	1958
10/15	29	2	+	+
15/20	48	7	14	1
20/25	164	17	20	18
25/30	95	71	55	151
30/35	74	110	179	100
35/40	135	103	317	124
40/45	219	205	181	227
45/50	163	292	92	190
50/55	50	147	83	85
55/60	14	38	42	59
60/65	6	5	11	31
65/70	2	2	3	9
70/75	+	1	1	3
75/80	+	—	1	1
> 80	—	—	1	1
Total	11,747	25,050	45,788	66,044

Table 35. Length distribution of haddock on the central grounds (‰)

Length, cm	1955	1956	1957	1958
10/15	2	37	2	1
15/20	5	7	16	14
20/25	30	42	26	86
25/30	49	104	73	268
30/35	132	126	142	252
35/40	330	105	192	75
40/45	315	201	82	58
45/50	111	179	83	53
50/55	15	85	145	32
55/60	4	41	150	32
60/65	2	16	36	43
65/70	1	12	15	31
70/75	+	7	13	11
75/80	1	10	7	10
> 80	—	15	18	34
Total	35,899	3,680	1,403	2,592

Table 36. Length distribution of haddock in the southern part of the Barents Sea (‰)

Length, cm	1955	1956	1957	1958
10/15	7	7	+	1
15/20	17	14	10	13
20/25	53	18	16	48
25/30	61	57	49	147
30/35	97	80	137	94
35/40	230	82	236	109
40/45	294	186	148	192
45/50	167	280	135	170
50/55	47	186	152	91
55/60	15	67	80	72
60/65	6	13	22	41
65/70	2	6	8	14
70/75	1	2	3	4
75/80	1	1	2	2
> 80	2	2	2	2
Total	88,262	101,226	102,028	94,815

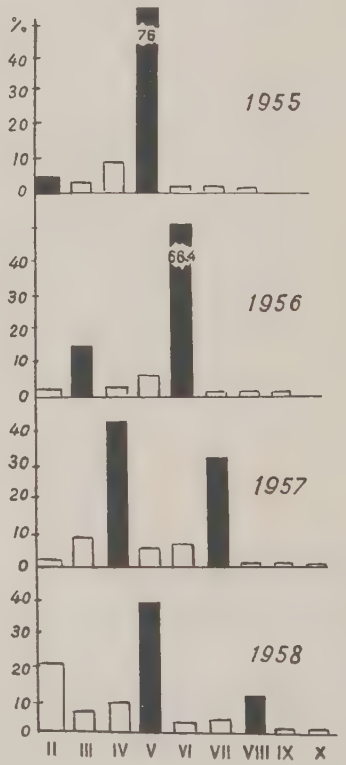


Figure 23. Age composition of haddock in the southern part of the Barents Sea.

groups 30/40 cm and 50/60 cm, but in 1958 a recruitment of younger fish entered the stock and at present the maximum is to be found in the 25/35 cm length group.

The catch per unit of effort decreased in the autumn of 1956 and remained on a very low level

in 1957 and 1958, particularly on the central and coastal grounds of the southern part of the sea.

Table 36 shows the length ranges of haddock for all grounds in the southern part of the Barents Sea. The changes in length distribution of the catches indicate that a considerable, or even the greatest, part of the shoals during the last two years has moved from the coastal and central grounds to the western grounds.

Figure 23 shows the age composition of haddock for the same four years for which we have given the length measurement data. The first two years are predominated by fish of the rich 1956 year-class; later on the importance of this year-class has, however, decreased considerably.

In 1957 the 1953 year-class was predominant by numbers, although the 1950 class was not much behind. In 1958, haddock of the 1953 year-class maintained its predominant position, but the new 1956 year-class had considerably decreased as the otolith and measurement data have shown. From the results of the fisheries and from the data given above the following conclusions may be drawn: (1) the strength of the 1953 year-class is considerably less than that of the 1950 class; (2) as to the importance of the 1956 year-class it seems to be less than that of 1950, but greater than that of 1953.

N. A. Maslov

Table 37. Aberdeen trawlers, market samples – Faroe haddock 1958

A. Number landed per 10 hours' fishing

Brood	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1957	—	—	—	—	—	—	—	—	22.7	10.2	15.9	34.8
1956	—	47.8	52.1	32.2	24.7	605.8	834.6	483.9	891.0	810.7	755.5	825.3
1955	346.7	202.1	256.1	302.7	439.0	454.2	809.0	600.4	195.9	191.3	515.1	184.4
1954	279.2	183.1	138.9	393.8	339.2	252.7	251.3	223.4	81.5	95.9	106.0	96.0
1953	184.5	130.2	68.8	214.5	214.1	133.9	155.7	171.1	51.7	61.9	74.6	36.6
1952	30.1	21.8	13.9	50.0	46.6	36.2	21.9	45.5	6.3	14.1	10.7	4.9
1951	5.5	6.0	6.6	24.7	17.6	27.0	21.7	27.4	2.5	5.4	2.1	1.3
1950	3.4	7.2	4.1	9.1	3.4	17.1	13.1	16.7	2.3	2.0	3.4	1.2
1949	2.4	4.7	1.5	9.5	1.8	5.3	6.4	8.8	0.2	0.9	0.3	0.6
1948	1.2	1.4	1.1	3.3	1.4	3.9	4.1	3.6	—	0.2	1.0	—
1947 and older	0.4	3.2	1.1	1.2	0.7	2.6	2.9	1.6	—	—	—	—
Total	853.4	607.5	544.2	1041.0	1088.5	1538.7	2120.7	1582.4	1254.1	1192.6	1484.6	1185.1

B. Mean lengths of each age-group sampled

1957	—	—	—	—	—	—	—	—	31.3	32.3	33.0	33.0
1956	—	32.4	35.3	33.2	32.9	35.0	34.5	35.6	36.5	36.7	37.5	38.2
1955	39.7	38.1	38.4	39.3	37.4	41.2	40.8	42.6	44.0	46.7	39.8	47.0
1954	46.7	44.4	44.8	44.9	43.2	47.9	46.0	48.3	49.2	49.7	46.6	50.5
1953	50.0	51.1	52.9	51.6	50.5	52.4	52.0	54.4	54.4	54.0	51.8	55.1
1952	57.3	59.0	58.9	56.4	55.2	60.2	60.3	57.4	60.5	54.5	57.8	60.0
1951	61.6	67.5	63.7	63.6	59.5	65.0	65.4	65.7	69.3	65.6	64.6	66.5
1950	65.3	67.0	67.2	66.2	70.3	68.2	68.7	67.8	67.1	72.2	68.2	69.0
1949	72.2	68.5	68.8	71.6	72.9	69.6	70.4	70.0	76.0	68.2	76.0	70.5
1948	70.7	72.4	74.0	72.2	70.5	73.4	71.8	69.8	—	73.0	71.8	—
1947 and older	70.0	72.8	70.8	79.5	75.0	72.8	69.3	69.6	—	—	—	—

C. Estimated weights[1]) landed per 10 hours' fishing (in cwt)

1957	—	—	—	—	—	—	—	—	0.11	0.06	0.10	0.21
1956	—	0.32	0.28	0.25	0.10	4.57	5.62	3.65	7.23	6.73	6.69	7.64
1955	2.62	1.71	1.73	3.77	4.47	5.91	9.23	7.87	2.82	3.35	5.58	3.29
1954	5.68	2.52	1.84	6.34	4.64	4.12	3.89	4.32	1.65	2.05	1.87	2.15
1953	4.05	2.94	2.80	5.28	4.00	3.04	3.74	4.82	1.46	1.71	1.81	1.08
1952	0.90	0.76	0.79	1.13	1.05	1.31	0.72	1.50	0.24	0.40	0.37	0.19
1951	0.18	0.28	0.37	0.94	0.54	1.73	1.10	1.37	0.14	0.26	0.10	0.06
1950	0.21	0.34	0.16	0.17	0.23	1.28	0.95	0.92	0.12	0.12	0.18	0.07
1949	0.25	0.24	0.06	0.31	0.12	0.42	0.49	0.50	0.01	0.05	0.02	0.04
1948	0.13	0.09	0.07	0.12	0.12	0.42	0.37	0.21	—	0.01	0.06	—
1947 and older	0.04	0.24	0.05	0.02	0.05	0.34	0.23	0.09	—	—	—	—
Total	14.06	9.44	8.15	18.33	15.32	23.14	26.34	25.25	13.78	14.74	16.78	14.73
Actual landings per 10 hours' by Aberdeen trawlers	13.31	9.39	8.52	19.57	13.61	20.01	25.11	24.36	13.22	14.02	16.45	14.12

[1]) Estimated using data from Russell 1914

Faroe Stock

Scottish Investigations

(Tables 37–38)

Market sampling of the Faroe haddock stock has been continued as in previous years and the data are given in Table 37.

The age composition of the haddock sampled from commercial trawlers is shown in Table 37 A. The mean lengths of each year-class are given in Table 37 B, and in Table 37 C are shown the estimated weights of each year-class landed per 10 hours' fishing each month. These were determined by converting the mean lengths in Table 37B to weights (using data from RUSSELL, 1914[1]) and then multiplying each by the appropriate numbers per 10 hours' fishing from Table 37 A.

As in previous years, the younger age-groups (II—V) made up the greater part of the landings.

[1]) RUSSELL, E.S., 1914. Fish Invest. Lond., Ser. 2, 1 (1).

Table 38. Landings of three size categories by Aberdeen trawlers from Faroe – 1958

(Cwt per 100 hours)

Month	Hours fishing	Large	Medium	Small	Total
January ...	3,432	28.3	46.5	58.3	133.1
February ..	4,875	33.4	30.6	29.9	93.9
March	7,433	24.7	29.3	31.2	85.2
April	6,608	61,7	77.9	56.1	195.7
May	2,700	40.4	50.7	45.0	136.1
June	9,340	57.2	57.6	85.3	200.1
July	11,591	65.4	76.9	108.8	251.1
August	8,136	75.3	79.3	89.0	243.6
September .	4,776	26.8	39.1	66.3	132.2
October ...	6,698	26.4	40.3	73.5	140.2
November .	4,328	27.9	49.8	86.8	164.5
December .	5,241	24.8	52.7	63.7	141.2
Total/Mean	75,158	45.5	55.9	71.4	172.8

There was also the usual tendency for the mean lengths to decrease during the spring, although this year the decrease was most pronounced from April to May, instead of from March to April.

Table 39. Age composition of haddock caught by F.R.S. "Explorer" in 1958 per 10 hours' trawling

Northern Area

Year-class	May/June		Aug./Sept.		Oct./Nov.		All cruises	
Number of hauls	6		3		6		15	
							Weighted means	
1958	—	—	87	(32)	597	(221)	427	(158)
1957	107	(40)	460	(170)	217	(80)	222	(82)
1956	433	(160)	147	(54)	300	(111)	323	(120)
1955	3,713	(1,375)	1,573	(583)	2,037	(754)	2,615	(969)
1954	460	(170)	460	(170)	453	(168)	457	(169)
1953	273	(101)	107	(40)	150	(56)	191	(71)
1952 and older.....	87	(32)	47	(17)	33	(12)	57	(21)

North Central Area

Year-class	May/June		Aug./Sept.		Oct./Nov.		All cruises	
Number of hauls	10		10		7		27	
							Weighted means	
1958	—	—	510	(189)	5,783	(2,142)	2,681	(993)
1957	97	(36)	54	(20)	186	(69)	104	(39)
1956	269	(100)	50	(19)	89	(33)	141	(52)
1955	2,047	(758)	1,622	(601)	3,560	(1,319)	2,282	(845)
1954	178	(66)	110	(41)	343	(127)	196	(73)
1953	103	(38)	80	(30)	80	(30)	89	(33)
1952 and older.....	69	(26)	56	(21)	103	(38)	73	(27)

Central Area

Year-class	May/June		Aug./Sept.		Oct./Nov.		All cruises	
Number of hauls	8		8		9		25	
							Weighted means	
1958	—	—	62	(23)	669	(248)	383	(142)
1957	84	(31)	280	(104)	313	(116)	229	(85)
1956	60	(22)	165	(61)	56	(21)	92	(34)
1955	692	(256)	2,075	(769)	727	(269)	1,147	(425)
1954	41	(15)	80	(30)	20	(7)	46	(17)
1953	9	(3)	60	(22)	11	(4)	26	(10)
1952 and older.....	14	(5)	2	(1)	2	(1)	6	(2)

Table 39 (continued)

Moray Firth and Orkney

Number of hauls / Year-class	May/June 3		Aug./Sept. 3		Oct./Nov. 4		All cruises 10 Weighted means	
1958	—	—	53	(20)	25	(9)	37	(14)
1957	0	(0)	487	(180)	0	(0)	146	(54)
1956	187	(69)	160	(59)	15	(6)	110	(41)
1955	487	(180)	4,000	(1,481)	955	(354)	1,728	(640)
1954	93	(34)	307	(114)	125	(46)	170	(63)
1953	40	(15)	240	(89)	35	(13)	98	(36)
1952 and older	20	(7)	167	(62)	5	(2)	58	(21)

Western Area[1])

Number of hauls / Year-class	May/June 3		Aug./Sept. 3		Oct./Nov. 4		All cruises 10 Weighted means	
1958	—	—	40	(15)	5	(2)	20	(7)
1957	0	(0)	0	(0)	10	(4)	4	(1)
1956	740	(274)	13	(5)	85	(31)	260	(96)
1955	3,627	(1,343)	1,787	(662)	965	(357)	2,010	(744)
1954	833	(309)	860	(319)	490	(181)	704	(261)
1953	327	(121)	247	(91)	285	(106)	286	(106)
1952 and older	160	(59)	127	(47)	120	(44)	134	(50)

The values in brackets give the catches per 10 hours' fishing in old "Explorer" units. Conversion Factor = $^1/_{2.7}$

[1]) West of Orkney and Shetland as far as 4°W only.

The average weights of haddock per 100 hours' fishing landed by Aberdeen trawlers from Faroe during 1958 are shown in Table 38. The mean catch of 172.8 cwt during 1958 provides the first decrease in catch per 100 hours' fishing that has occurred since the catch per unit started to increase from a value of 125 cwt in 1952.

R. Jones

North Sea Stock

Scottish Investigations

(Tables 39–41)

Age composition

During 1958, F.R.S. "Explorer" completed three routine trawling cruises in the North Sea. The age composition of the haddock captured per 10 hours' trawling is shown in Table 39. The 1955 year-class was the predominant one in all areas, even though

Table 40. Mean lengths (cm) and standard errors of haddock of each age-group from the North Sea 1958

Year-class	Age	Cruise	Northern Area Mean	S. E.	Number of fish	North Central Area Mean	S. E.	Number of fish	Central Area Mean	S. E.	Number of fish
1958	0+	Aug./Sept.	11.45	±0.87	13	12.85	±0.71	255	9.47	±0.72	25
		Oct./Nov.	15.76	±0.42	179	15.53	±0.42	2,024	16.83	±0.36	301
1957	1+	May/June	18.48	±0.68	32	20.01	±0.69	48	21.32	±0.61	34
		Aug./Sept.	25.80	±1.10	69	24.63	±0.66	27	25.00	±0.56	112
		Oct./Nov.	27.76	±0.49	65	27.23	±0.48	65	28.94	±0.49	141
1956	2+	May/June	28.69	+0.80	130	28.21	±0.72	135	26.48	±1.00	24
		Aug./Sept.	31.42	±0.87	22	31.26	±0.65	25	30.31	±0.81	66
		Oct./Nov.	34.00	±0.80	90	30.90	±0.79	31	32.70	±1.04	25
1955	3+	May/June	31.34	±1.55	1,114	30.97	±1.42	1,024	32.01	±1.88	277
		Aug./Sept.	32.49	±1.54	236	33.63	±1.21	811	34.25	±1.24	830
		Oct./Nov.	35.49	±1.26	611	34.46	±1.89	1,246	35.27	±1.64	327
1954	4+	May/June	36.74	±1.10	138	37.57	±0.93	89	40.25	±1.07	17
		Aug./Sept	36.85	±1.20	69	40.92	±0.80	55	39.14	±1.12	32
		Oct./Nov.	39.59	±1.92	136	40.54	±1.95	120	42.36	±2.20	9
1953	5+	May/June	39.32	±1.96	82	40.61	±1.53	52	42.14	±2.65	4
		Aug./Sept.	39.98	±1.03	16	43.45	±0.67	40	41.42	±0.86	24
		Oct./Nov.	43.21	±1.49	45	47.05	±1.72	28	45.80	±2.15	5

Table 40 (continued)

Year-class	Age	Cruise	Moray Firth and Orkney Mean	S. E.	Number of fish	Western Area Mean	S. E.	Number of fish
1958	0+	Aug./Sept.	13.80	±1.15	8	10.00	±1.16	6
		Oct./Nov.	20.42	±0.62	5	13.00	±1.20	1
1957	1+	May/June	—	—	—	—	—	—
		Aug./Sept.	25.43	±1.19	73	—	—	—
		Oct./Nov.	—	—	—	29.00	±1.13	2
1956	2+	May/June	26.90	±1.38	28	29.40	±0.95	111
		Aug./Sept.	29.40	±1.13	24	29.50	±1.47	2
		Oct./Nov.	33.67	±1.41	3	33.29	±1.02	17
1955	3+	May/June	30.59	±2.56	73	31.83	±1.66	544
		Aug./Sept.	32.71	±2.20	600	32.74	±1.87	268
		Oct./Nov.	39.66	±1.73	191	34.67	±1.48	193
1954	4+	May/June	38.12	±2.02	14	37.74	±1.29	125
		Aug./Sept.	38.67	±1.63	46	35.53	±1.50	129
		Oct./Nov.	45.58	±2.48	25	38.95	±2.13	98
1953	5+	May/June	42.30	±2.57	6	42.32	±1.79	49
		Aug./Sept.	37.39	±0.87	36	39.26	±0.73	37
		Oct./Nov.	44.16	±2.29	7	41.16	±2.04	57

Table 41. Landings of haddock by British steam trawlers from North Sea in 1958

Quarterly period	North of Lat. 57°30′N Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Lat. 55°N to 57°30′N Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	South of Lat. 55°00′N Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	All areas Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.
Jan.–March ...	742	423	175	211	248	85	18	715	3	971	1,386	70
April–June ...	872	451	193	161	357	45	14	502	3	1,047	1,310	80

it had just entered its fourth year of life. The poor quality of the 1956 year-class was apparent in all areas as indeed was also that of the 1957 year-class.

0-group haddock (1958 year-class) were present in the August/September and October/November cruises only. The weighted mean catch per 10 hours for both cruises and all areas was 366 in old "Explorer" units. On the basis of these figures it is likely to be a moderately good brood.

Size composition

The mean lengths of haddock sampled in 1958 are given in Table 40.

British statistics

The haddock landings from the North Sea by British steam trawlers during 1958 are given in Table 41.

R. Jones
J. Main

German Investigations

(Figure 24; Tables 42–45)

Sampling of North Sea haddock was carried out as in previous years by experimental trawling with the F.R.S. "Anton Dohrn". In May—June 1958 the research vessel took part in the international programme for comparative fishing and gear selection in co-operation with "Explorer" and "Willem Beukelsz". The fishing experiments were made off the Firth of Forth and in the Buchan Deep. Of the numerous hauls of "Anton Dohrn" those made with a herring trawl with different cod-ends of 75 mm mesh size and a small mesh cover were selected. The haddock and whiting caught during these hauls were investigated as to age composition. The results for haddock are shown in Table 42. A summary of the mean lengths of these fish is given in Table 43 (for whiting, see page 121, Tables 49 and 50).

In October 1958, age composition and length distribution of haddock were analysed in the experimental catches of "Anton Dohrn" taken with

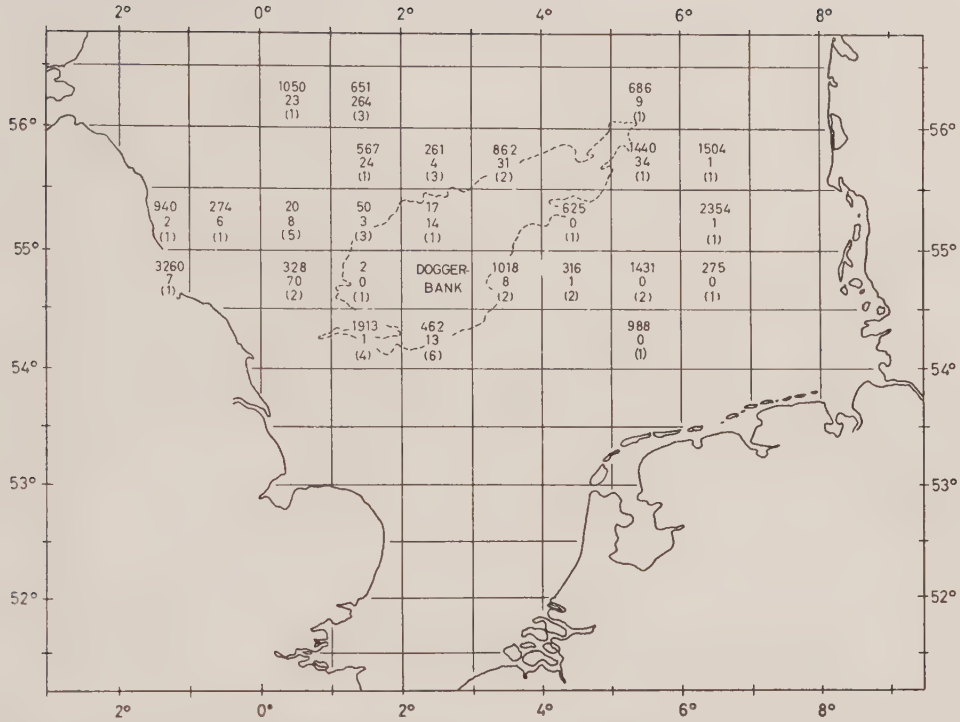


Figure 24. Mean catch of haddock and whiting taken per half-hour trawling of F.R.S. "Anton Dohrn" in the North Sea in October 1958 (herring trawl). Above: whiting, Below: haddock. In brackets: number of hauls in each rectangle.

Table 42. Mean catch per 10 hours' trawling (number of fish) and age composition (%) of haddock caught by F.R.S. «Anton Dohrn» in the North Sea in June 1958

(Bottom trawl with small mesh cover)

Age-group	Year-class	56°02′–56°12′N 1°36′– 2°22′W		57°25′–57°36′N 1°00′– 1°28′W	
I	1957	252	(36)	4,390	(71)
II	1956	18	(2)	79	(1)
III	1955	399	(57)	1,563	(25)
IV	1954	19	(3)	117	(2)
V	1953	12	(2)	38	(1)
VI	1952	+	(+)	16	(+)
VII+	1951–	—	—	2	(+)
All Ages		700	(100)	6,205	(100)
Trawl stations .		26		33	

Table 43. Mean lengths (cm) of haddock caught by F.R.S. «Anton Dohrn» in the North Sea in June 1958

(Bottom trawl with small mesh cover)

Age-group	Year-class	56°02′–56°12′N 1°36′– 2°22′W Mean	Range	Number of fish	57°25′–57°36′N 1°00′– 1°28′W Mean	Range	Number of fish
I	1957	22.3	14—26	92	21.3	15—26	64
II	1956	27.9	24—31	7	26.2	25—28	8
III	1955	33.3	26—42	192	33.0	24—43	171
IV	1954	39.7	33—44	12	38.2	34—57	45
V	1953	44.3	40—50	6	44.8	38—55	30
VI	1952	(53.5)	53	1	51.3	43—60	21
VII+	1951–	—	—	—	(61.7)	56—66	3

Table 44. Mean catch per 10 hours' trawling (number of fish) and age composition (%) of haddock caught by F.R.S. «Anton Dohrn» in the North Sea in October 1958

(Herring trawl)

Age-group	Year-class	Dogger Bank		SW Dogger		German Bight	
0	1958	85	(9)	4	(2)	40	(41)
I	1957	342	(35)	—	—	20	(21)
II	1956	78	(8)	6	(3)	2	(2)
III	1955	449	(46)	150	(78)	33	(34)
IV	1954	14	(1)	30	(16)	1	(1)
V	1953	11	(1)	—	—	—	—
VI	1952	1	(+)	2	(1)	1	(1)
All ages		980	(100)	192	(100)	97	(100)
Trawl stations .		23		10		13	

the ordinary herring trawl in the German Bight and Dogger Bank areas (Tables 44 and 45).

The outstandingly good 1955 year-class predominated still in 1958, as in the preceding years, in most of the areas. Besides, only the 1957 year-class was abundantly represented, especially in the Buchan Deep area. This year-class, however, is only moderately abundant, and therefore the mean catch of haddock per unit effort has strongly decreased in the areas visited. The poor 1956 year-class was hardly present in the catches.

Table 45. Mean lengths (cm) of haddock caught by F.R.S. „Anton Dohrn in the North Sea in October 1958
(Herring trawl)

Age-group	Year-class	Dogger Bank Mean	Range	Number of fish	SW-Dogger Mean	Range	Number of fish	German Bight Mean	Range	Number of fish
0	1958	15.6	11—19	98	(14.5)	14	2	15.7	12—17	25
I	1957	29.6	24—35	190	—	—	—	29.2	25—32	12
II	1956	32.1	25—37	45	(33.8)	33—34	3	(36.5)	36	1
III	1955	36.9	27—49	287	43.5	33—54	75	40.8	33—49	8
IV	1954	37.4	33—40	6	47.6	39—58	15	(46.5)	46	1
V	1953	43.2	39—47	7	—	—	—	—	—	—
VI	1952	(42.5)	42	1	(74.5)	74	1	(71.5)	71	1

0-group haddock of the 1958 year-class were found in October 1958 in the German Bight and the Dogger Bank area in very small numbers only, but this observation does not give enough evidence for concluding the relative strength of the 1958 year-class, because the areas in the northern North Sea were not visited.

The average catch per unit effort of haddock and whiting by rectangles worked up after the experimental trawling data of October 1958 is given in Figure 24.

D. Sahrhage

POLLACK

Constitution du Stock de Lieu Jaune débarqué à La Rochelle

(Figure 25)

Le lieu jaune (*Gadus pollachius* L.) est un poisson qui entre pour une faible part dans les apports des chalutiers rochelais, 0,37% des apports en 1946[1]). Ceux-ci le capturent de la mer d'Irlande à sa limite méridionale des îles Berligues.

Des observations effectuées en 1957 et 1958 au débarquement, montrent les résultats suivants: —

Le stock d'hiver du groupe III au groupe VII est compris entre les tailles limites de 40 et 95 cm. Le groupe V est le plus important (plus de 40% du stock) et correspond à la taille modale de 70 cm.

L'été le groupe IV prédomine (près de 35% du stock) pour une taille modale de 55 cm.

Il est à noter que les modes de 55 et 70 cm que nous attribuons respectivement aux groupes IV et V correspondent aux valeurs indiquées par Stuart Thomson, 1904—06[2]), pour la région de la Cornouaille anglaise. Un travail ultérieur précisera certaines variations de croissance avec la latitude.

J. Moreau

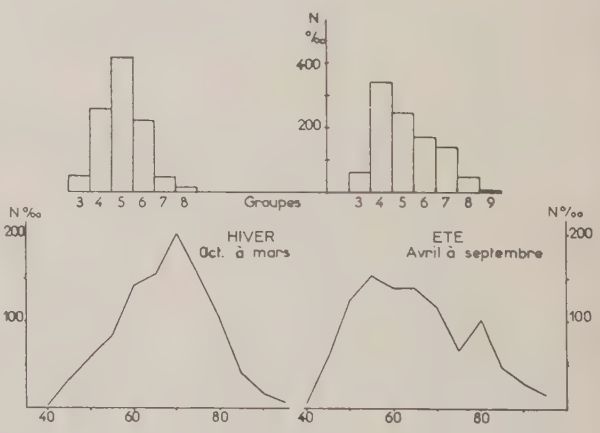


Figure 25. Tailles (cm) observées et constitution du stock suivant la saison.

Références

1) Letaconnoux, R., 1948. "Effets de la guerre sur la constitution du stock de poisson". Rapp. Cons. Explor. Mer, 122.

2) Stuart Thomson, J., 1904—06. "The periodic growth of scales in Gadidae". J. mar. biol. Ass. U.K., 7.

WHITING

North Sea Stock

Scottish Investigations

(Tables 46–48)

Age composition

The age composition of the whiting captured by F.R.S. "Explorer" in the North Sea during 1958 is shown in Table 46. Three routine trawling cruises were made during the year and the data from these are set out in the form adopted for haddock only expressed in new "Explorer" units. In all regions the 1955 year-class was well represented, while those of 1956 and 1957 appear to be generally poor.

Size composition

The mean lengths of whiting sampled by the "Explorer" during 1958 are given in Table 47. This shows that the largest fish at all ages were found in the Western Area, while those in the Northern Area were second largest.

British statistics

A summary of the whiting landings by British steam trawlers from the North Sea in 1958 is given in Table 48.

R. Jones,
R. Gamble

German Investigations

(Figures 26–27; Tables 49–52)

The composition of the whiting population was analysed in the catches made in May—June 1958 by F.R.S. "Anton Dohrn" during the international comparative fishing experiments outside the Firth of Forth and in the Buchan Deep area (for details see page 116). The mean number of whiting caught per 30 min. trawling and the percentage age composition are shown in Table 49, the corresponding mean lengths are given in Table 50.

Sampling of whiting was continued in October 1958 on board "Anton Dohrn" in the German Bight and Dogger Bank areas. Figure 26 shows

Table 46. Age composition of whiting caught by F.R.S. «Explorer» per 10 hours' trawling in 1958

	Northern Area				North Central Area				Central Area			
	May/ June	Aug./ Sept.	Oct./ Nov.	All cruises	May/ June	Aug./ Sept.	Oct./ Nov.	All cruises	May/ June	Aug./ Sept.	Oct./ Nov.	All cruises
Number of hauls	6	3	6	15	10	10	9	29	8	8	9	25
Year-class				Weighted means				Weighted means				Weighted means
1958	—	0	0	0	—	538	1,018	765	—	110	42	74
1957	0	0	0	0	20	2	427	140	142	688	284	368
1956	10	0	30	16	118	64	1,191	432	70	1,002	531	534
1955	957	640	1,047	930	1,937	934	4,036	2,243	138	2,410	1,560	1,377
1954	485	367	383	421	283	388	698	448	16	252	313	198
1953	172	160	177	172	113	66	138	105	1	10	64	27
1952 and older	458	187	127	271	192	302	740	400	10	285	267	191

	Moray Firth and Orkney				Western Area				Southern Area
	May/ June	Aug./ Sept.	Oct. Nov.	All cruises	May/ June	Aug./ Sept.	Oct./ Nov.	All cruises	May/ June
Number of hauls	3	3	4	10	3	3	4	10	10
Year-class				Weighted means				Weighted means	
1958	—	0	1,215	694	—	0	0	0	—
1957	0	0	90	36	0	0	5	2	1,476
1956	207	140	215	190	20	13	40	26	190
1955	647	240	85	300	613	87	565	436	367
1954	127	60	25	66	153	53	430	234	18
1953	80	40	0	36	133	13	145	102	5
1952 and older	420	107	35	172	407	53	830	470	9

Table 47. Mean lengths (cm) and standard errors of whitting of each age-group from the North Sea in 1958

Year-class	Age	Cruise	Northern Area Mean	S. E.	Number of fish	North Central Area Mean	S. E.	Number of fish	Central Area Mean	S. E.	Number of fish
1958	0+	Aug./Sept.	—	—	—	11.26	±0.24	269	10.89	±1.09	44
		Oct./Nov.	—	—	—	14.19	±0.73	458	14.38	±0.73	19
1957	1+	May/June	—	—	—	16.59	±0.65	10	17.90	±0.43	57
		Aug./Sept.	—	—	—	16.20	±1.55	1	22.30	±0.12	275
		Oct./Nov.	—	—	—	24.21	±0.42	192	24.04	±0.50	128
1956	2+	May/June	27.67	±2.12	3	26.98	±0.96	59	24.18	±1.08	28
		Aug./Sept.	—	—	—	27.47	±0.46	32	24.86	±0.34	401
		Oct./Nov.	28.77	±0.74	9	27.09	±0.30	536	27.21	±0.37	220
1955	3+	May/June	29.89	±0.55	287	28.57	±0.42	969	28.18	±0.50	55
		Aug./Sept:	32.66	±0.65	96	30.59	±0.33	467	29.48	±0.48	964
		Oct./Nov.	32.32	±0.56	314	30.52	±0.54	1,816	30.75	±0.47	702
1954	4+	May/June	31.64	±0.58	146	30.85	±0.44	142	30.98	±1.25	7
		Aug./Sept.	33.71	±1.78	55	32.50	±1.11	194	29.47	±1.30	101
		Oct./Nov.	33.63	±0.77	115	32.34	±0.68	314	32.43	±0.62	141
1953	5+	May/June	33.59	±0.64	52	32.24	±0.58	57	29.00	±4.92	1
		Aug./Sept.	36.15	±0.64	24	33.17	±0.53	33	32.00	±1.48	4
		Oct./Nov.	34.08	±1.04	53	34.44	±0.89	62	34.52	±1.06	29

Year-class	Age	Cruise	Moray Firth and Orkney Mean	S. E.	Number of fish	Western Area Mean	S. E.	Number of fish	Southern Area Mean	S. E.	Number of fish
1958	0+	Aug./Sept.	—	—	—	—	—	—	—	—	—
		Oct./Nov.	12.97	±0.92	243	—	—	—	—	—	—
1957	1+	May/June	—	—	—	—	—	—	17.23	±0.19	738
		Aug./Sept.	—	—	—	—	—	—	—	—	—
		Oct./Nov.	26.07	±0.80	18	22.00	±1.55	1	—	—	—
1956	2+	May/June	23.03	±2.00	31	28.70	±2.50	3	23.70	±1.01	95
		Aug./Sept.	26.02	±0.59	21	29.50	±1.43	2	—	—	—
		Oct./Nov.	27.74	±0.60	43	29.50	±0.91	8	—	—	—
1955	3+	May/June	29.03	±0.82	97	31.15	±0.66	92	29.00	±0.39	184
		Aug./Sept.	30.01	±0.68	36	32.60	±0.96	13	—	—	—
		Oct./Nov.	33.54	±0.99	17	35.44	±1.26	113	—	—	—
1954	4+	May/June	30.80	±1.05	19	35.15	±0.80	23	30.02	±1.04	9
		Aug./Sept.	33.20	±2.27	9	37.39	±2.28	8	—	—	—
		Oct./Nov.	35.80	±2.05	5	39.28	±1.21	86	—	—	—
1953	5+	May/June	35.25	±1.14	12	38.40	±0.90	20	34.62	±2.23	3
		Aug./Sept.	30.50	±1.22	6	42.50	±2.08	2	—	—	—
		Oct./Nov.	—	—	—	43.66	±1.27	29	—	—	—

Table 48. Landings of whiting by British steam trawlers from the North Sea in 1958

Quarterly period	North of Lat. 57°30′N Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Lat. 55°N to 57°30′N Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	South of Lat. 55°00′N Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	All areas Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.
Jan./March.....	391	423	92	70	248	28	11	715	2	472	1,386	34
April/June	212	451	47	39	357	11	13	502	3	264	1,310	20

the position of the trawling stations and the boundaries between the areas chosen. The results of these investigations are set out in Tables 51 and 52.

On the whole, the average catches of whiting per unit effort in the German Bight and around the Dogger Bank were approximately of the same order as in 1957 (see Table 51 and Figure 24, page 117). The 1955 year-class which predominated in 1957 has, however, lost its importance in these areas. Instead the bulk of the whiting catches was formed by the 1956 and 1957 year-classes, the latter especially being predominant in the Firth of Forth and Buchan Deep areas.

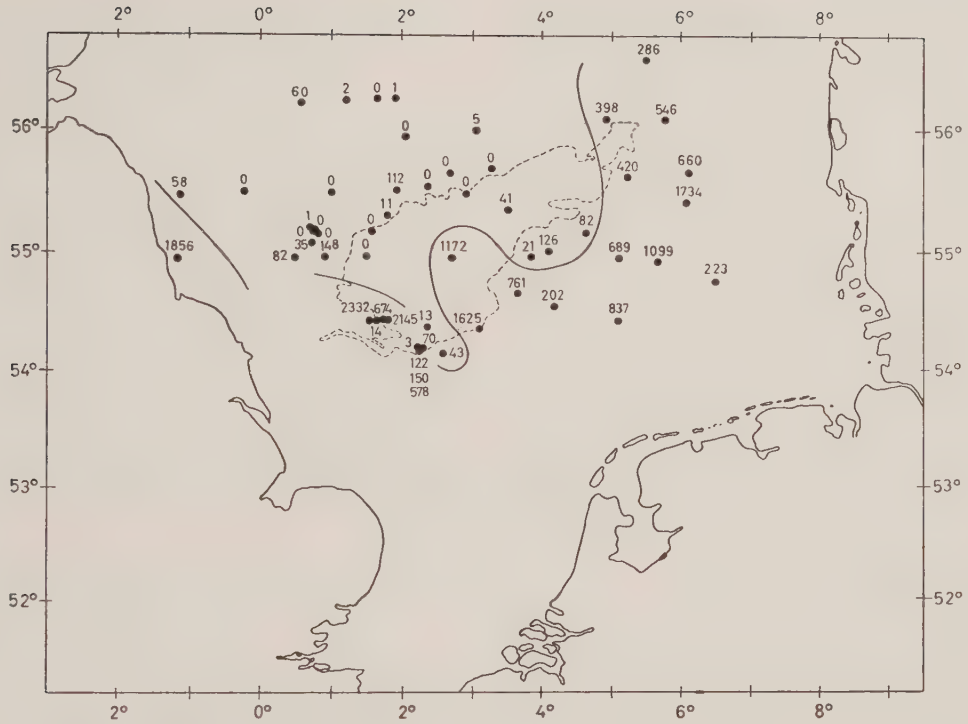


Figure 26. Boundaries between the areas mentioned in Tables 51 and 52, and positions of trawl stations of F.R.S. "Anton Dohrn" in October 1958 at which this whiting material was sampled.

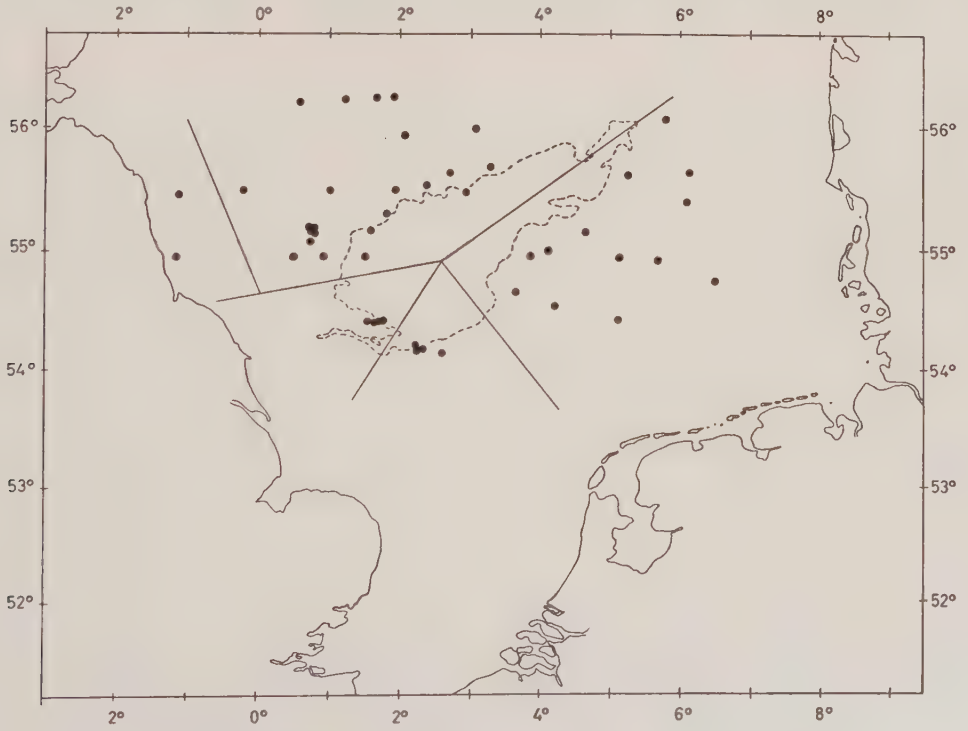


Figure 27. Catches of 0-group whiting (1958 year-class) per 30 min. trawling with F.R.S. "Anton Dohrn" in October 1958 (herring trawl). The isoline of 200 whiting caught per 30 min. haul is shown.

Table 49. Mean catch per 30 min. trawling (number of fish) and age composition (%) of whiting caught by F.R.S. «Anton Dohrn» in the North Sea in June 1958

(Bottom trawl with small mesh cover)

Age-group	Year-class	56°02′–56°12′N 1°36′– 2°22′W		57°25′–57°36′N 1°00′– 1°28′W	
I	1957	375	(66)	523	(77)
II	1956	57	(10)	36	(5)
III	1955	62	(11)	67	(10)
IV	1954	36	(6)	37	(5)
V	1953	4	(1)	6	(1)
VI	1952	19	(4)	8	(1)
VII	1951	13	(2)	3	(1)
VIII	1950	+	(+)	—	—
All ages		566	(100)	680	(100)
Trawl stations .		26		33	

Table 50. Mean lengths (cm) of whitting caught by F.R.S. «Anton Dohrn» in the North Sea in June 1958

(Bottom trawl with small mesh cover)

Age-group	Year-class	56°02′–56°12′N 1°36′– 2°22′W Mean	Range	Number of fish	57°25′–57°36′N 1°00′– 1°28′W Mean	Range	Number of fish
I	1957	17.9	11—25	28	19.8	13—25	67
II	1956	23.9	21—29	21	24.2	22—26	8
III	1955	28.8	25—35	58	28.1	25—36	37
IV	1954	30.2	27—37	42	29.0	25—37	28
V	1953	33.1	30—36	8	31.3	29—46	12
VI	1952	34.5	28—48	41	33.7	31—45	36
VII	1951	35.2	30—51	31	33.1	30—47	12
VIII	1950	(35.5)	35	1	—	—	—

Table 51. Mean catch per 30 min. trawling (number of fish) and age composition (%) of whiting caught by F.R.S. "Anton Dohrn" in the North Sea in October 1958

(Herring trawl)

Age-group	Year-class	Shields Area		Dogger Bank		S-Dogger		W-Dogger		German Bight	
0	1958	957	(46)	20	(7)	137	(34)	1,294	(68)	571	(55)
I	1957	851	(41)	120	(39)	49	(12)	182	(10)	141	(14)
II	1956	257	(12)	82	(27)	138	(35)	349	(18)	227	(22)
III	1955	31	(1)	70	(24)	58	(15)	85	(4)	82	(8)
IV	1954	4	(+)	10	(3)	10	(3)	2	(+)	10	(1)
V	1953	—	—	1	(+)	4	(1)	2	(+)	—	—
VI	1952	—	—	1	(+)	—	—	—	—	—	—
VII+	1951–	—	—	+	(+)	—	—	—	—	+	(+)
All ages		2,100	(100)	304	(100)	396	(100)	1,914	(100)	1,031	(100)
Trawl stations		2		23		7		4		13	

Table 52. Mean lengths (cm) of whiting caught by F.R.S. «Anton Dohrn» in the North Sea in October 1958

(Herring trawl)

Age-group	Year-class	Shields Area Mean	Range	Number of fish	Dogger Bank Mean	Range	Number of fish	S-Dogger Mean	Range	Number of fish	W-Dogger Mean	Range	Number of fish[1])	German Bight Mean	Range	Number of fish
0	1958	12.9	7—16	27	(13.4)	8—18	4	12.8	8—17	24	13.7	8—18	178	13.8	7—18	178
I	1957	22.0	18—26	154	24.1	18—29	194	23.8	19—28	101	21.2	17—24	128	21.0	17—24	128
II	1956	25.2	21—31	78	25.7	19—33	142	26.6	20—33	175	23.6	19—28	186	23.5	19—28	186
III	1955	30.0	27—33	31	29.6	21—37	175	31.3	23—40	75	26.6	22—31	101	28.0	22—37	101
IV	1954	(32.5)	30—35	4	32.7	28—38	41	33.1	29—44	12	31.1	29—34	11	33.4	29—41	11
V	1953	—	—	—	(36.1)	33—42	4	(38.6)	34—48	3	(39.4)	38—40	1	—	—	—
VI	1952	—	—	—	(37.2)	34—44	6	—	—	—	—	—	—	—	—	—
VII	1951	—	—	—	(40.7)	38—44	2	—	—	—	—	—	—	(49.5)	49	1

[1]) Conversion of length composition by means of age determinations for the German Bight area.

Whitings of the 0-group (1958 year-class) were encountered in October 1958 in considerable numbers, and this year-class seems to be fairly good. As shown in Figure 27, 0-group whiting were plentiful east of the Dogger Bank, in the German Bight, at the south-western edge of the Dogger, and also in the Shields area. However, north of the Dogger Bank only poor catches of small whiting were made. These observations are in good agreement with the results obtained last year (see Ann. Biol., 15: 145, Fig. 27).

D. Sahrhage

Baltic Stock

German Investigations

(Tables 53–54)

The stock of whiting in the western part of the Baltic is maintained by transport of brood and by migration of young fish (0-group) from the Kattegat. It seems that in general no spawning takes place in the western Baltic, as no eggs were ever found in the Kiel Bay, though fish with ripening gonads, both males and females are found in the spring. As no fully ripe specimen could be obtained in 1956 and 1957, artificial fertilization could not be carried out to prove the influence of salinity on the fertilization and development of the eggs. The number of whiting rapidly decreases when they reach the size and age for propagation, and therefore it is to be supposed that the majority migrates back northwards to the region of higher salinity to spawn.

The frequency of whiting in the Kiel Bay and the waters around Fehmarn varies from year to year, as seen from Table 53.

The catches in the autumn, winter, and early spring show that in each year remarkable quantities of the youngest year-class (0-group) are present in the western Baltic, sometimes outnumbering the cod of the same year-class (see p. 104). In general the number decreases for age-group I, and older specimens are mostly scarce. In our material from experimental catches in 1956/58, only 5.5% of the whiting were longer than 20 cm and 0.2% longer than 30 cm, whereas 41% of the cod were more than 30 cm long. Obviously the stock of young whiting in the western Baltic suffers heavy losses by predation, fishing, and migration. Consequently landing of whiting of marketable size by the commercial fishery is of no significance.

Maturity starts in the third year of life at a length of 22 cm in both sexes. The majority of the maturing fish were 25—39 cm in length. For estimating the fecundity, H. Hoffmeister counted the number of eggs in 37 females at stage IV. The numbers ranged from 108,000 to 221,000, the relation between the fecundity (F) and the weight of the fish (W, in g) or the length (L, in cm) are given by the following equations: —

$$F = 85{,}700 + 273.5 \cdot W \quad \text{(standard deviation } \pm 14{,}200)$$
$$= 72{,}200 + 2.404 \cdot L^3 \quad \text{(standard deviation } \pm 14{,}100)$$
$$= 8{,}100\ (L - 12.9) \quad \text{(standard deviation } \pm 13{,}000)$$

With sufficient approximation, we can assume a linear relation between the number of eggs and the length, although an exponential function would correspond better with the existing linear relation between the number of eggs and the weight.

Table 53. Length and age distribution of whiting in hauls made with the standard trawl in the western Baltic, 1956–1958

Date	Number of stat.	Number of fish caught	Number per hour's fishing: 5 cm groups 6–10	11–15	16–20	21–25	26–30	31–35	36–40	Age-groups 0	I	II	III	IV	Total	Ratio whiting: cod (cod = 100)
May/June 1956 ...	14	529	8	21	1	0.1	—	—	—	—	30	0.3	0.1	—	30	69
October 1956	13	1,160	47	30	5	7	1	0.2	—	57	25	7	1	0.2	90	90
April/June 1957 ..	23	226	0.3	6	2	0.4	0.3	—	—	—	6.5	2	0.6	—	9	14
Jan./March 1958 ..	6	488	13	33	6	1	1	0.2	0.1	51	3	0.5	—	—	54	102
July 1958	11	73	0.1	6	1	0.1	0.1	—	—	—	6	1	—	—	7	14
October 1958	7	473	56	26	9	2	2	—	0.2	78	13	3	0.2	—	95	99

Table 54. Average number of vertebrae of whiting in the western Baltic (Kiel Bay), Kattegat, Skagerak and North Sea (Great Fisher Bank)

Area	No. invest.	Vert. S.		Vert. praeh.		Vert. haem.	
(1) Western Baltic	320	54.18	±0.046	19.57	±0.030	34.61	±0.048
(2) Kattegat	101	54.40	±0.089	19.70	±0.069	34.70	±0.091
(3) Skagerak	104	54.77	±0.078	19.78	±0.057	34.99	±0.073
(4) North Sea	200	54.77	±0.067	19.92	±0.038	34.85	±0.065
Difference (1) — (2)		−0.22	±0.100	−0.13	±0.075	−0.09	±0.103
Difference (1) — (3)		−0.59	±0.091[1])	−0.21	±0.064[1])	−0.38	±0.087[1])
Difference (1) — (4)		−0.59	±0.082[1])	−0.35	±0.048[1])	−0.24	±0.082
Difference (2) — (3)		−0.37	±0.118[1])	−0.08	±0.089	−0.29	±0.116
Difference (3) — (4)		0.0		0.14	±0.068	−0.14	±0.098

[1]) significant

Regarding the fecundity as a linear function of the weight and the cube of the length, we obtain two equations with an additive factor which is several times higher than the standard deviation. There is no simple proportion between F and W or L^3 as the quotients F/W and F/L^3 become smaller with increasing size of the fish. The fecundity of the Baltic whiting is similar to that found by D. S. Raitt for the haddock in the North Sea.

In regard to the racial characteristics of the whiting in the Kiel Bay, the results of Hoffmeister help to solve the question to which population the Baltic whiting belongs. In Table 54 his vertebrae countings are given, together with those of Joh. Schmidt for the whiting of the Skagerak.

The average number of vertebrae is lowest in Kiel Bay and highest in the North Sea and in the Skagerak. The Kattegat whiting has intermediate values, but they are nearer to those of the Kiel Bay. Proving the significance of the differences between the mean values of the different populations, we find the average vertebral numbers of the whiting significantly changing from the Skagerak to the Kattegat. The populations in the Skagerak and the adjacent parts of the North Sea (see data of A. Dannevig in Ann. Biol. 1947, and of M. Roessingh in Ann. Biol. 1957) are not different as regard to this morphological character, and the Baltic whiting do not differ significantly from the Kattegat whiting, though perhaps the slight decrease of Vert. S. is not caused by random sampling, but exists in reality as it does for many fish species in the Baltic.

R. Kändler

Herring

INTRODUCTION

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The most important feature of the Distant Northern Seas herring fisheries, revealed by the Norwegian and Icelandic contributions, was their relative failure. The Norwegian winter fishery gave a total yield which was less than half the 1957 figure, while the north Icelandic coast fishery was the fourteenth in a series of poor seasons.

The Norwegian contribution indicates that the failure of the winter fishery was due partly to adverse weather conditions, partly to relatively low recruitment, and partly to the spread northwards of cold Baltic water, which restricted the movement southwards of the main herring concentrations. In the Icelandic fishery, Norwegian herring were again relatively scarce. This was revealed by Icelandic »racial« analyses of the north coast material, which showed that Icelandic spring spawners were the dominant group; this was confirmed by the Norwegian tagging experiments.

The excellent conjoint international programme in the Norwegian Sea again provided valuable data on the distribution of herring in the open ocean and their relation with temperature. This and subsequent Norwegian cruises, provided information on the migration routes and time of arrival off the Norwegian coast.

Important information on the distribution of herring catches, and of spring spawned larvae in the region of the Faroes is provided by the Soviet contribution.

The most striking and important feature of the herring stocks in the North Sea in 1958 was the continued scarcity of adult herring in the Southern Bight and eastern English Channel. This was particularly marked in the eastern English Channel, where the trawl fisheries again terminated early due to poor catches. In contrast, the summer fisheries in the northern and central regions of the North Sea were generally good. This was especially so in the north-eastern North Sea in the spring and the Shetland area in the summer. The adult herring appeared to have a distinctly marked northerly distribution in 1958. Age data show that the three year-old recruits (1955 year-class) were relatively scarce in both the northern and southern regions. This, and the low abundance of the older age-groups was responsible for the poor Southern Bight fishery. In the northern North Sea, however, the older age-groups, amongst which the 1954 and 1952 year-classes were prominent, were more abundant and maintained the fisheries at a relatively high level.

An interesting survey by Polish and East German workers, of the distribution of herring and of bottom temperature in the northern North Sea in summer showed no clear relation between them. This is contrary to the bottom temperature/herring distribution relations established in recent years by other workers, and it illustrates the need for futher intensive studies of the factors governing the distribution, concentration, and movement of the herring stocks in the North Sea.

As in 1957, an intensive fishery was carried out in late winter in the region to the south of Ireland

(Dunmore). This fishery was again a relatively good one, especially in January.

The industrial fishery for adolescent herring in the region to the south and east of the Dogger (Bløden fishery) gave better yields than in 1957. The Danish investigations indicate that in both the spring and autumn seasons, the fishery was centred, principally, on the 1956 year-class, the members of which were smaller, age for age, than in any preceding Bløden season. Members of this year-class should recruit the adult fisheries, as 3 year-olds in 1959. The autumn season was also marked by the appearance of concentrations of larger members of this year-class north-west of the Dogger.

In a further attempt to measure the fishing mortality rate of the Bløden stock, and additionally to obtain information on its subsequent dispersal from the nursery areas, a conjoint international tagging experiment was again conducted in this area in August 1958. The results of this experiment indicate that the fishing mortality rate was approximately the same as in 1957. No data on the subsequent dispersal are yet available.

An interesting feature of the herring stocks in the Skagerak, Kattegat, Belt Sea, and Baltic revealed by Danish investigations, was the presence of unusually large numbers of autumn spawned fish of North Sea origin in the Belts. Many autumn herring of local origin gave rise to large concentrations of young herring, which augurs well for the human consumption autumn fisheries in the Belts.

B. B. Parrish

A. Distant Northern Seas

COMMERCIAL FISH

The Icelandic North Coast Herring in 1958

(Figures 1–3; Tables 1–7)

The size of the north coast fishery was about the same as in 1957. In the seasons of 1956, 1957, and 1958 the participation has been as follows:—

Year	Vessels	G.R.T.
1956	187	14,380
1957	234	18,592
1958	241	17,915

The total catch amounted to 830,850 hl, as compared with 987,609 hl in 1957 and 760,848 hl in 1956. As most of the boats are now fishing with ring-nets it is easy to compare the average yields per effort by disregarding the other vessels.During the last three seasons the yields have been the following: 1956, 3,784 hl; 1957, 4,042 hl; and 1958, 3,277 hl. These figures show that 1958 was a very poor fishing season, the 14th in a series of poor seasons.

The material collected in 1958 comprises 54 samples containing approximately 5,000 fish. Samples Nos. 37, 39, and 51 consisted mainly of immature fish, and Nos. 52, 53, and 54 were taken west of the fishing area proper after the end of the season. These six samples have no connexion with the main fishery and are therefore not considered in the tables. The localities from which the samples originated are shown in Figure 1, specified by months. It appears from the figure that the catches were distributed over the whole north coast area in each of the three months covered by the sampling, and that many samples originated from catches taken far off shore.

If the samples mentioned above are excluded, the average length of all north coast herring proved to be 35.69 cm, which is about the same as in 1956 (35.70) but much higher than in 1957 (34.96). Table 1 shows the length distribution and the average lengths from month to month, both for purse-seine and drift-net herring. The table reveals that the lengths were similar in June and July, but they decreased very much in August towards the end of the season.

The composition of the catches as to tribes is shown in Table 2. The situation was almost the same as in 1957, the outstanding features being: (1) an unusually low proportion of Norwegian herring, 215‰ (198‰ in 1957), (2) a very high proportion of summer spawners (156‰ in 1958 and 215‰ in 1957). These two »abnormalities« were, however, not quite so pronounced as in 1957. In June nearly 80% of the catches consisted of Icelandic spring spawners, whereas the catches in

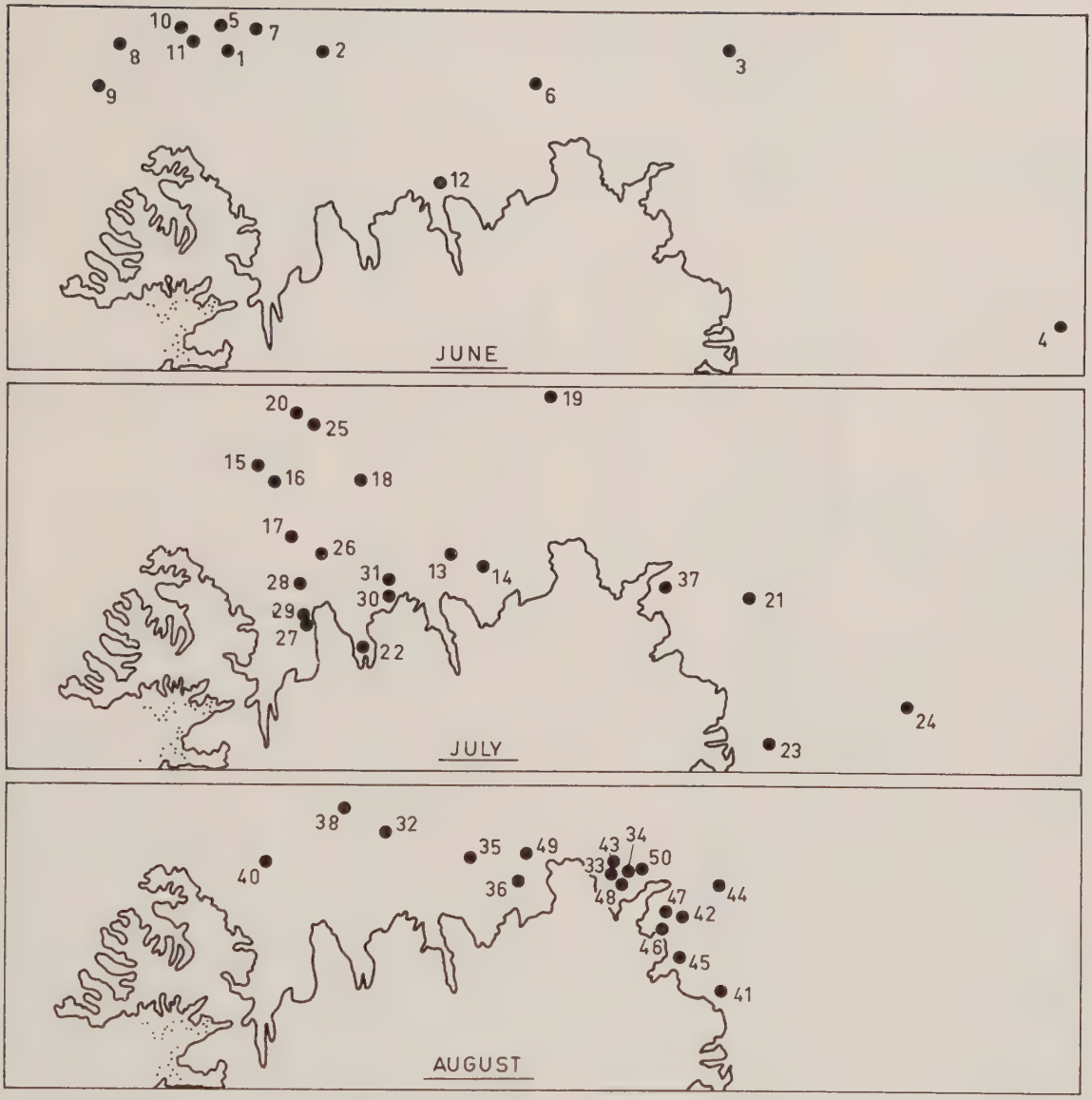

Figure 1. Localities of sampling in 1958.

July were characterized by a relatively high proportion of Norwegian herring (226‰). The catches taken in August contained unusually large numbers of summer spawners (312‰), but still much fewer than in 1957 (482‰).

The retreat of the Norwegian herring in August (192‰) and the appearance of the summer spawners caused the decrease in length.

The age composition of the tribes in 1958 is shown in Table 3 and Figure 2. The relative strength of the tribes has already been dealt with, and thus only the age distribution is left for consideration.

As in 1957, 21 year-classes were represented in the catches, aged from 2 to 22 years, and the same year-classes were generally predominant. In the northern Norwegian tribe the 1947 and 1950 year-classes were the most important and the average age was 11.9 years, or somewhat lower than in 1957 (12.3). This was due to the relatively sparser occurrence of old fish than in the previous year.

Table 1. Length distribution of north coast herring (‰)

Gear	Purse-seine and ring-nets				Drift-nets				Grand total
Month	June	July	Aug.	Total	June	July	Aug.	Total	
Sample Nos.-	1–2 5–12	13–18 20–31	33–36 41–50		3–4	19	32, 38 40		
Length, cm									
41	—	1	—	+	—	—	—	—	+
40	1	3	—	2	—	—	—	—	1
39	9	22	7	14	27	20	4	15	14
38	60	95	29	66	59	80	28	48	64
37	220	224	171	208	268	180	92	169	202
36	**315**	216	**257**	**255**	**272**	**340**	104	**207**	248
35	211	202	194	202	176	180	140	160	196
34	126	120	161	132	107	160	200	160	138
33	38	67	91	67	75	30	**240**	144	77
32	15	33	43	31	16	10	120	63	36
31	4	12	32	16	—	—	56	26	17
30	1	3	10	5	—	—	12	6	5
29	—	1	4	2	—	—	4	2	2
28	—	1	—	+	—	—	—	—	+
27	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—
25	—	—	1	+	—	—	—	—	+
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number of fish	911	1784	1196	3891	187	100	250	537	4428
Mean	35.78	35.63	34.95	35.50	35.88	35.77	34.04	35.37	35.69

Table 2. Relative strength of the tribes

Tribes	June	July	August	Total
NN	150	218	175	187
NS	24	38	17	28
ISPR	798	632	496	629
ISUM	28	112	312	156
Total	1000	1000	1000	1000
Number	976	1622	1272	3870

NN = North Norway type
NS = South Norway type
ISPR = Icelandic spring spawners
ISUM = Icelandic summer spawners

In the southern Norwegian tribe the 1947 year-class was by far the strongest, exactly as in 1957. The average age was lower, 10.3 years as compared with 11.0, mainly owing to the fact that there were relatively many 7 and 8 year-old fish; it must, however, be remembered that this tribe contributed very little to the catches.

The Icelandic spring spawning tribe was composed of the same year-classes as in 1957, the 1945, 1949, 1950, and 1951 classes predominating. The mean age was therefore considerably higher, viz., 9.2 years as compared with 8.2. The summer spawning tribe showed also a similar composition as in 1957 with 6 and 7 year-old herring predominating. The average age, which was 7.2 years, was therefore higher than in the previous season (6.7).

It can be concluded that no new year-classes appeared in any of the tribes but the abundance of Norwegian herring showed a slight trend towards increase.

Table 3. Age of north coast herring in 1958

Age	Year	NN	NS	ISPR	ISUM	?[1])	Total
2	1956	—	—	+	—	—	+
3	1955	—	—	1	2	14	1
4	1954	—	—	7	50	14	13
5	1953	2	—	42	163	27	52
6	1952	13	19	58	**235**	**110**	78
7	1951	**95**	**168**	136	**201**	**165**	143
8	1950	**175**	**158**	**235**	149	27	213
9	1949	39	9	**186**	87	68	139
10	1948	84	65	63	18	68	60
11	1947	**146**	**376**	41	20	**193**	67
12	1946	80	47	65	26	27	61
13	1945	55	28	**130**	**37**	27	97
14	1944	49	**65**	18	5	41	22
15	1943	**67**	38	7	—	**96**	18
16	1942	33	9	5	—	27	9
17	1941	**46**	9	4	2	—	11
18	1940	43	—	1	3	27	6
19	1939	24	—	1	2	41	6
20	1938	34	—	—	—	14	1
21	1937	12	9	—	—	14	3
22	1936	3	—	—	—	—	+
Total		1000	1000	1000	1000	1000	1000
Number		673	107	2435	602	73	3890
?[2])		49	—	—	4	485	538
Total number		722	107	2435	606	558	4428
‰		187	28	629	156	—	1000
Average age		11.9	10.3	9.2	7.2	10.6	9.3

[1]) Scales not fit for determination of type.

[2]) Scales not fit for age reading.

NN = North Norway type
NS = South Norway type
ISPR = Icelandic spring spawners
ISUM = Icelandic summer spawners

Table 4. Total number of vertebrae by tribes

V.S.	NN	NS	ISPR	ISUM	?	Total
59	17	28	17	3	7	14
58	228	187	290	144	233	250
57	631	655	589	657	584	605
56	123	121	99	180	176	125
55	1	9	5	16	—	6
Total	1000	1000	1000	1000	1000	1000
Number	722	107	2435	606	558	4428
V.S.	57.14	57.10	57.22	56.94	57.07	57.14
± m	0.02	0.10	0.02	0.03	0.04	0.02

Table 5. Total number of vertebrae by maturity

		A		B			
Maturity	Number	V.S.	± m	VIII	V	IV	III
II	19	57.00	0.10	1.4	0.7	1.8	1.8
III	1549	57.18	0.01	2.9	3.2	0.4	—
IV	159	57.20	0.05	1.5	3.1	—	—
V	33	56.86	0.10	2.8	—	—	—
VII	15	56.29	—	—	—	—	—
VIII	2653	57.14	0.01	—	—	—	—

In Table 4 a survey of the distribution of vertebrae etc. is given within the various tribes. In the northern Norwegian tribe the vertebral count was lower (57.14) than in 1957 (57.18), and in the southern tribe it was considerably lower, being 57.10 as compared with 57.22 in 1957. The Icelandic spring spawners, on the other hand, showed higher counts (57.20) than in 1957 (57.18) and a similar tendency could be noted in the summer spawners (56.94 as compared with 56.92). The average number of vertebrae for all tribes was exactly the same as in 1957 (57.14).

Table 5 shows the number of vertebrae at the various maturity stages. The figures under heading B show the difference between the groups of maturity. The difference is indicated in relation to the standard deviation of the difference between the groups compared. It appears clearly that the fish in stages II, V, and VII must consist of summer spawners as they have a low number of vertebrae and do not differ from each other. They differ, however, very much from III and IV. As was the case last year there is a considerable difference between stages III and VIII, indicating that group VIII must contain a certain number of summer spawners. This is also clearly revealed by the survey given in Table 6. In June, all the herring in stage VIII must be spring spawners, whereas in August that group contains probably summer spawners only, and in July the group must be mixed. The increasing abundance of summer spawners in maturity group VIII in July was also revealed through the fact that the average number of vertebrae in this group was 57.14 in the period

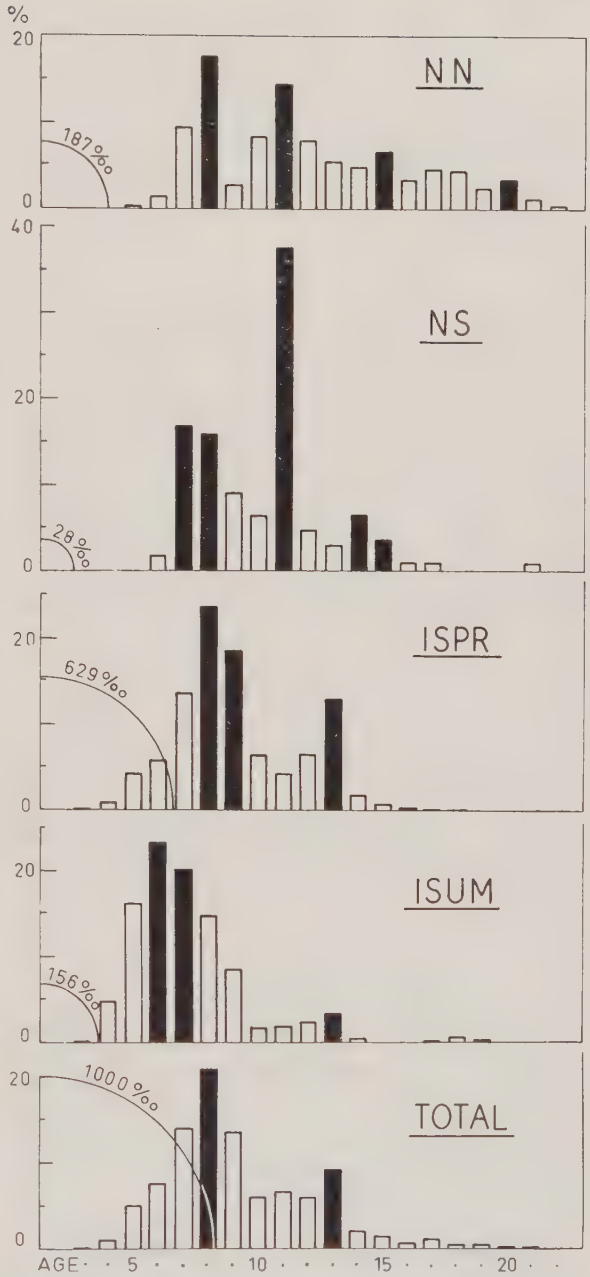

Figure 2. Age distribution in the different tribes in 1958, and the relative number of fish in each tribe (circles at left).

Table 6. Comparison by months of herring at stage VIII

Month	Number	V.S.	± m	August	July
June	967	57.27	0.02	9.3	6.0
July	1073	57.09	0.02	3.3	—
August	613	56.99	0.02	—	—

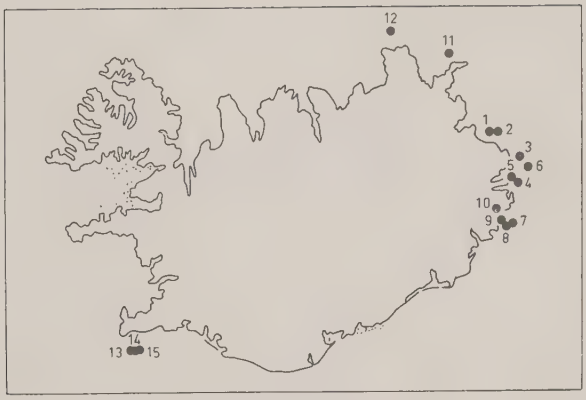

Figure 3. Localities of tagging in 1958.

from 1. July to 10. July, 57.07 from 11. to 20. July, and 57.00 from 21. to 30. July.

The feeding conditions were generally good as may be seen from the following table, which indicate the average amount of *Calanus* (cm^3) in the herring stomachs throughout the season:—

11.—20. June	9.4	(11.0)
21.—30. ,, ...	10.6	(9.1)
1.—10. July	6.3	(10.5)
11.—20. ,, ...	4.8	(6.6)
21.—31. ,, ...	8.1	(3.4)
1.—10. August	9.5	(0.9)
11.—20. ,, ...	10.0	(none)
21.—31. ,, ...	none	(none)

The figures in parentheses show the corresponding values in 1957. It should be mentioned that the herring stomachs contained no sand-eel larvae this year.

The average amount of intestinal fat was 1.6 for all three months as well as for the whole season. This is identical with the figure for 1957.

Mention should be made of the six samples referred to above and which were not included in the tables. Samples Nos. 37, 39, and 51 comprising 228 fish were taken off the east coast. They contained only two fish of Norwegian origin and were a mixture of Icelandic spring and summer spawners. The mean length was 27.9 cm and the average age 3.4 years. More than 70% of these fish were three and four years old. In samples Nos. 52, 53, and 54, which originated from the NW coast there were only herring of Icelandic origin containing about 90% summer spawners. The average length was 33.5 cm and the age 6.4 years. Several age-groups were represented but 6 and 7 year-old fish were most abundant (50.7%).

Table 7 shows the number of internal tags returned from all parts of Iceland in 1958. The recoveries were much less than in 1957, viz. 141 as compared with 508 in the previous year. The average

Table 7. Returns of tagged herring in 1958

Year	N coast	E coast	SW coast	Norway	Total
Returns A					
Liberations					
1952	5	1	—	—	6
1953	5	2	1	—	8
1954	12	—	—	—	12
1955	8	2	—	1	11
1956	22	2	—	—	24
1957	12	10	—	1	23
1958	—	1	—	—	1
Total	64	18	1	2	85
Returns B					
1951	—	—	—	1	1
1952	—	—	—	—	—
1953	1	—	—	—	1
1954	7	—	—	—	7
1955	4	1	—	—	5
1956	2	2	—	—	4
1957	4	14	—	2	20
1958	1	11	—	—	12
Total	19	28	0	3	50
Returns C					
1954	—	—	1	—	1
1955	—	—	—	—	—
1956	1	—	—	—	1
1957	1	1	1	—	3
1958	—	—	1	—	1
Total	2	1	3	0	6
Grand total	85	47	4	5	141

A = Returns from N coast factories
B = ,, ,, E ,, ,,
C = ,, ,, SW ,, ,,

number of tags returned from 100,000 hl of herring processed in the north and east coast plants were also much lower, being 34.3 in 1958 and 49.6 in 1957. The corresponding indices for Norwegian returns from the same plants were 1.0 in 1957 and 1.4 in 1958, indicating that there were some more Norwegian herring in the catches. This change, as compared with 1957, is also slightly indicated by the composition of the stock as to tribes, mentioned in connexion with Tables 2. It is also interesting to note that there was only one return from the SW coast in the north coast plants and none in those of the east coast. It should also be noted that at the north coast relatively many more recaptures were taken of herring which had been tagged off the north coast (64) than of those tagged off the east coast (18), and more east coast tags (28) than north coast tags (19) were found in the east coast plants. It is also seen that north and east coast tags were reported from the SW coast but no Norwegian tags were found there.

Figure 3 shows the localities of tagging in 1958. Owing to adverse weather when the tagging

experiments started in July and small yields from the north coast area at the end of the season nearly all the taggings were carried out on the east coast, many of them in the fjords. The herring liberated in 1958 were consequently smaller than in previous years, the average length being 31.82 cm in 1958 as compared with 35.33 cm in 1958, and still larger herring in earlier years. Many of the fish liberated were therefore immature including a considerable proportion of 2 and 3 year-olds. In all, 9,594 herring were liberated off the north and east coasts of Iceland.

ÁRNI FRIÐRIKSSON

Norwegian Herring Investigations in the Norwegian Sea, 1958

In collaboration with Danish, Icelandic, and Soviet research ships the Norwegian Sea was covered with a fairly dense net of hydrographical stations in June. Charts were constructed based on these observations, showing temperature and the concentration of herring recorded by Asdic and echo-sounder.

In July/August the R/V "G. O. Sars" continued the investigations in the Norwegian Sea, locating herring shoals and reporting to the Norwegian fleet, fishing herring along the Polar Front. A cruise for hydrographical observation and location of herring was undertaken in November and one in December. The herring were located further north and west than usual, and made it possible to forecast that the arrival of the herring in Norwegian coastal water would be late in January. The actual arrival was 26. January 1959.

FINN DEVOLD

Norwegian Fat and Small Herring Investigations, 1958

During November (10.—29.) a cruise was undertaken with the R/V "G. O. Sars" to the area off northern Norway (Troms and Finnmark). The purpose of the cruise was to locate immature herring shoals and to make hydrographical observations. The cruise was considerably curtailed by bad weather, and we were therefore forced to work in more inshore waters. The temperature at the surface varied from 7° to 8°C in the coastal water between Andfjord and North Cape. This is relatively warmer than usual.

The fat and small herring fishery in Troms and Finnmark started this autumn earlier than the previous year. At the end of September purse-seiners took good catches of small herring. The season, however, closed at the end of November, which is one month earlier than usual.

Samples taken during the season show that the catches consisted of three year-classes (1958, 1957, and 1956). The 1958 and 1957 year-classes predominated in the catches.

OLAV DRAGESUND

Norwegian Tagging Experiments in 1958

(Tables 8–9)

Only three categories of herring were tagged in 1958. The beach-seine fishery was extremely poor also in the winter of 1958 and it was impossible to secure live fish for large-herring tagging.

During the tagging experiments of spring herring and "forfangstsild" in 1958, successful attempts were also made to take scales of each herring which was tagged with an internal steel tag. The number and categories tagged are listed in Table 8.

In the summer of 1958, the Norwegian fishing fleet started the herring fishery earlier than usual off north and east Iceland, utilizing the fish for the purpose of reducing it into oil and meal. Herring caught from the middle of June to the end of July were landed at oil and meal factories in Norway. This fishery gave an opportunity for the recovery of tags from the above mentioned area, so that a comparison could be made of recapture

Table 8. Taggings in 1958

Area	Date		Number of liberations by type of tag
	Spring herring		
Tveitevåg (S of Bergen)	6–21. III.	10,888	9,998 internal 400 external 490 int. and ext.
	«Forfangstsild»		
Aure (N. of Kristiansund)	22. IV.	1,000	900 internal 100 external
Møstavåg (S of Kristiansund)	26–28. IV	1,300	1,100 internal 100 external 100 int. and ext.
Frohavet (N of Trondheimsfjord)	6–8. V	3,200	2,850 internal 200 external 150 int. and ext.
	Fat herring		
Porsangerfjord (Finnmark)	20. XI.	1,575	1,350 internal 225 external

Table 9. Number of returns in 1958 from the different experiments

Year of tagging	Category	Number tagged	Recaptures from: The winter herring season	Recaptures from: The north and east coast herring season
1948	NH	7,475	—	1
1951	,,	3,065	1	2
1952	,,	17,308	12	8
1953	,,	10,181	7	9
1954	,,	8,783	11	22
1955	,,	11,732	16	32
1956	,,	8,443	23	48
1957	,,	7,899	21	39
		Total	91	161
1948	SH	6,018	1	—
1949	SH	8,261	1	1
1950	LH	9,085	1	—
1951	LH	5,998	1	—
1951	SH	9,986	3	2
1952	LH	10,295	2	—
1952	SH	10,863	20	1
1952	FH	7,971	4	—
1953	LH	10,080	—	2
1953	SH	10,046	3	—
1954	LH	10,042	4	—
1954	SH	10,291	12	2
1954	FH	14,970	5	—
1955	LH	10,045	19	1
1955	SH	9,087	4	—
1955	FH	13,586	13	—
1956	LH	4,998	4	—
1956	FH	12,799	9	—
1957	LH	9,500	16	—
1957	SH	8,450	16	—
1957	FH	3,900	6	1
		Total	144	10

NH = North and east coast herring.
SH = Spring herring.
LH = Large herring.
FH = Fat herring and "Forfangstsild".

with those of the Norwegian winter herring fishery.

406 internal tags were received from the factories this year, 235 during the winter herring season and 171 during the herring season off Iceland. The recaptures from the taggings in 1958 and tags received from those factories which do not possess magnets have not been taken into consideration. The number of tags recovered from the different experiments during the two seasons are shown in Table 9.

Of the 235 recovered tags during the winter herring season, 144 were released as spring and large herring, fat herring and "forfangstsild" at the Norwegian coast; 91 were tagged as north and east coast herring off Iceland.

The composition of the recaptures during the north and east coast herring season off Iceland this summer is particularly interesting. The striking point is that out of 171 recovered tags, 161 have been tagged off north and east Iceland, whereas only 10 were released at the Norwegian coast.

According to Friðriksson (1956) the Icelandic spring spawners contributed only 4.2—17.1% of the total catch off north Iceland during the period 1949/1953, but the percentage of their contribution in 1954 and 1955 was 39.1 and 39.6 respectively.

This immigration of Icelandic spring spawners to the north coast herring grounds, partly explains the disproportion in the number of Norwegian and Icelandic tags recaptured at the Norwegian coast and off Iceland.

One more reason to this disproportion may also be that the older age-groups of the Norwegian herring population, spawning off the Norwegian coast, segregate to the feeding areas off Iceland. The average age of the Norwegian spring spawners off north Iceland during the period 1948/1955 was 14.1 for the northern type and 11.1 for the southern type (Friðriksson, 1956). This is rather higher than the mean age for the herring off the Norwegian coast during the winter herring fishery, which was 9.38 for the northern and 6.30 for the southern type during the same period. The strong 1950 year-class, therefore, which showed up in the catches during the Norwegian winter herring fishery in 1955, and also partly in 1954, has been tagged in large numbers every year at the Norwegian coast, whereas a relatively small number of the same year-class has been tagged off north and east Iceland.

Olav Dragesund

Reference

Friðriksson, Á., 1956. "The tribes in the north coast herring of Iceland with special reference to the period 1948—1955." Rapp. et Proc.-Verb., 143(2): 36—44.

Quelques Particularités de la Ponte des Harengs Atlanto-Scandinaves dans la Région des Féroés

(Figures 4–5; Tableaux 10–11)

Les recherches soviétiques concernant la reproduction des harengs atlanto-scandinaves dans la région des Féroés ont considérablement élargi nos connaissances touchant la ponte et ses particularités dans cette région dans des différentes années. Concurrement avec le développement de la pêche de harengs on a fait en 1955, 1956 et 1958 un examen consciencieux des frayères situées dans les bas-fonds entourant l'archipel.

L'exploration de 1955 a été effectuée par le navire océanographique "Académicien Bergue" (chef d'expédition A. P. Wilson); celle de 1956

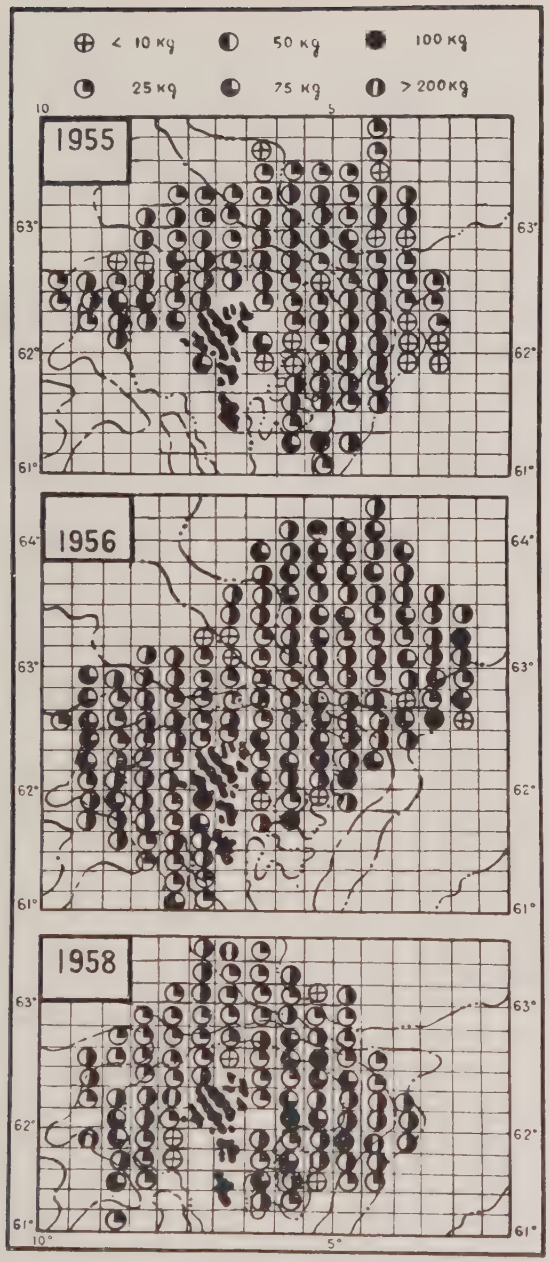

Figure 4. Répartition de la pêche au filet dérivant et les apports de harengs, par filet en kg en mars de 1955, 1956 et 1958.

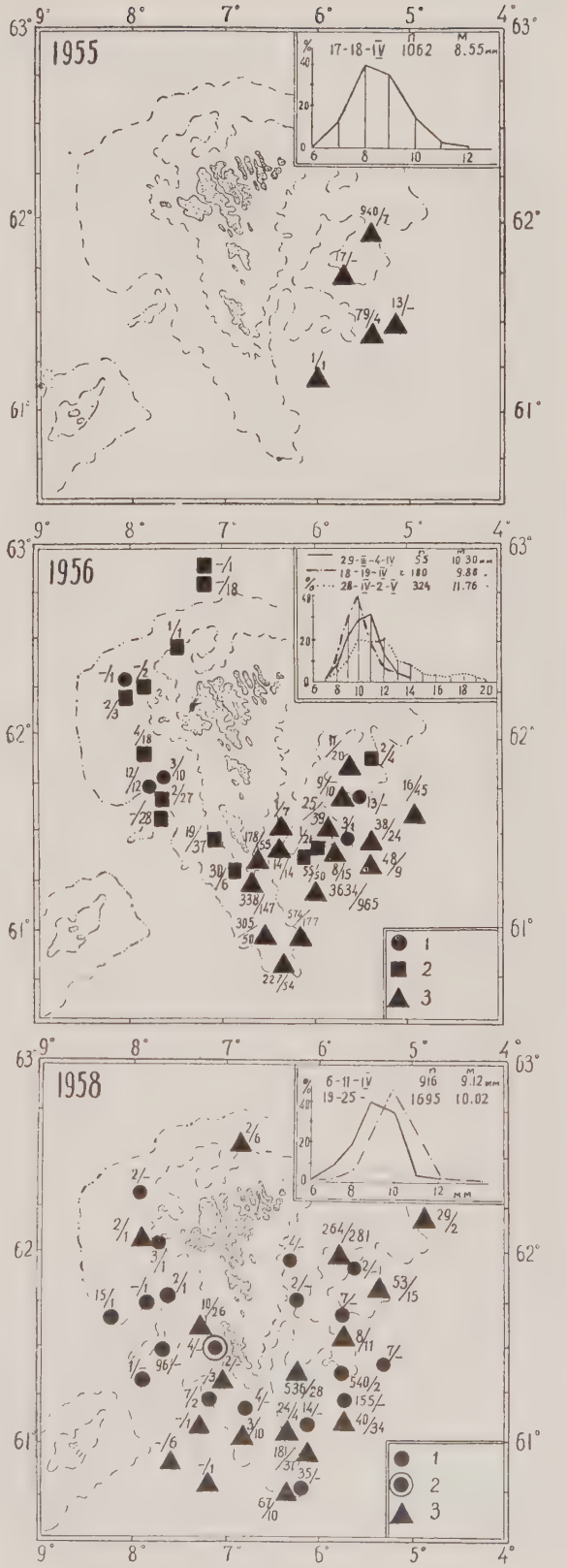

Figure 5.

Figure 5. Répartition des pêches ichtyoplanctoniques contenant des larves de harengs.

Stations ichtyoplanctoniques. 1955, 1956. I: 29 mars/4 avril; II: 18/19 avril; III: 28 avril/2 mai. 1958: I: 6/11 avril; II: en même période réitérativement; III: 19/25 avril. Les chiffres inscrits près des stations indiquent le nombre de larves capturées; le numérateur indique le nombre de larves, dont la longueur est moins de 10 mm; le dénominateur indique le nombre de larves, dont la longueur est plus de 10 mm. Les courbes montrent la composition par taille. n = nombre de larves capturées, m = taille moyenne en mm.

par le "Professeur Mesyatsev" (sous direction de A. P. Wilson); celle de 1958 par l' "Académicien Bergue" (chef B. S. Soloviev). Les Figures 4 et 5 nous serviront à décrire les résultats de la répartition de la pêche au filet dérivant des larges concentrations de harengs à l'époque précédant la ponte et ceux de la récolte des larves. L'étendu des recherches et les résultats de la capture des larves sont représentés dans le Tableau 10.

Tableau 10. L'étendu des recherches en 1955, 1956 et 1958

Années	Nombre de stations océanographiques		Nombre de captures		Nombre de larves capturées	
	Total	Avec des larves	Total	Avec des larves	Total	10 mm
1955	49	6	111	9	1062	1050
1956	69	33	167	53	7454	5827
1958	97	37	271	75	2611	2131

Un nombre dominant de larves, dont les dimensions sont moins de 10 mm, peut être capturé sur l'aire de ponte où à sa proximité immédiate, cela donne le droit de juger des termes et des endroits où la ponte s'effectue de la manière la plus intense.

La pêche des larves de harengs se réalise à l'aide d'un filet ichtyoplanctonique, fait de gaze de soie No. 140, qui est tenu par le câble "Hercule". On descend ces filets, employé à la pêche horizontale dans des couches particulières, par séries, à chaque station océanographique, à la circulation du navire à petite vitesse au cours de 15 minutes. Le plus souvent la pêche se réalise à l'aide de 3 filets, qui embrassent la masse d'eau de 100 m (de la surface à 100 m de profondeur). Dans quelques cas l'on pêche dans la couche près du fond. Les stations océanographiques ont été établies entre les isobathes des 100 m et des 200 m. Les principales secteurs des frayères ont été étudiés deux fois de suite et en 1956 même trois fois de suite pendant 10—14 jours.

La première investigation, effectuée avec beaucoup de soin en 1956 dans des limites de toute la région des bas-fonds du 23 mars au 7 avril, n'a pas donné de résultats positifs. Ce n'est qu'à la reprise de l'investigation de la pente d'Orient, effectuée du 16 au 18 avril, qu'on a découvert un grand nombre de larves de harengs. Leurs dimensions relativement petites et la présence du sac vitellin qui ne s'est pas résorbé entièrement, témoignent que l'éclosion des oeufs a eu lieu du 8 au 10 avril et que la ponte a atteint son plein du 15 au 20 mars.

Lors de la première exploration qui a eu lieu du 29 mars au 4 avril 1956, on a déjà découvert un petit nombre de larves de harengs sur la descente d'Orient aussi que sur celle d'Occident. Plusieurs des larves avaient une taille de plus de 10 mm ce qui indique que la majorité a été transportée à cette région par le courant d'eau des bancs, situés au sud et au sud-ouest de l'archipel. Une exploration réitérative de toute la zone des bas-fonds, qui a eu lieu du 18 au 19 avril, a apporté le plus grand nombre de larves; l'énorme majorité d'entre eux représentait les plus jeune stades, longueur moins de 10 mm; néanmoins, 20% des larves avaient déjà atteint une taille de 11 à 14 mm; ce résultat donne une idée de la précocité de la ponte de 1956 dans cette région en comparaison avec celle de 1955. Les stations, faites à la 3ième exploration des aires principales de la ponte, qui a duré du 28 avril au 2 mai, ont donné un nombre d'individus considérablement réduit, mais la présence de plus de 30% de plus jeunes stades montre évidemment que dans cette

Tableau 11. Composition par taille des larves, capturées à différentes profondeurs à l'époque du 17 au 25 avril en 1955, 1956 et 1958

mm	Pourcentage des larves capturées									
	17–18 avril 1955			18–19 avril 1956				19–25 avril 1958		
	2–5 m	75–100 m	125–150 m	2–5 m	50 m	100 m	150 m	25 m	50 m	100 m
6	—	—	—	—	—	—	0.2	0.6	—	—
7	3.6	16.3	12.8	—	0.9	1.1	1.9	0.7	0.3	—
8	14.3	36.8	39.6	2.7	4.9	7.1	12.4	7.8	5.8	5.1
9	25.0	23.8	37.0	14.9	26.1	26.3	38.6	15.1	12.7	27.4
10	35.7	21.1	10.0	42.3	40.6	43.5	36.4	35.5	52.6	42.1
Total	78.6	98.0	99.4	59.9	72.5	78.0	89.5	59.7	71.4	74.6
11	14.3	2.0	0.6	30.8	20.3	17.0	9.1	27.0	26.0	24.1
12	7.1	—	—	6.9	5.7	4.2	1.3	10.0	2.1	1.0
13	—	—	—	2.4	1.4	0.2	0.1	3.3	0.5	0.3
14	—	—	—	+	0.1	0.1	—	—	—	—
Total	21.4	2.0	0.6	40.1	27.5	22.0	10.5	40.3	28.6	25.4
Nombres capturés	28	147	887	1236	1782	1858	2199	152	377	1164
Taille moyenne ...	9.69	8.65	8.51	10.37	10.03	9.89	9.47	10.22	10.11	9.94

région la ponte a duré du 10—15 mars aux premiers jours d'avril.

En 1957 l'exploration des frayères n'a pas eu lieu. Au début de l'exploration de cette région en 1958 on a capturé, du 6 a 11 avril, un grand nombre de larves de harengs, dont la plus grande partie avait une taille d'au moins 10 mm. A la 2ième exploration, du 19 au 25 avril, on a observé une quantité de larves beaucoup plus grande. Il y avait parmi eux près de 30% de larves, dont la taille dépassait 10 mm, ce qui nous permets de constater que l'époque où la ponte atteint son climax a eu lieu beaucoup plus tôt qu'en 1956 et surtout qu'en 1955.

Afin d'éclaircir la question de ponte d'été dans cette région le navire océanographique "Professeur Somov" (chef d'expédition K. A. Liamine) a exploré, en 1958, cette région du 15 au 18 août. Malgré l'examen consciencieux de toute la zone des bas-fonds: la pêche par séries, à 3—4 horizons (93 prises d'eau), — 25 stations océanographiques n'ont apporté aucune larve. En 1934 les investigateurs danois n'ont pas non plus obtenu de résultats positifs dans la pêche de larves de harengs d'été; c'est pourquoi nous nous permettons de supposer que les individus adultes de la race d'été ne se reproduisent jamais dans cette région. A l'époque de leurs migrations vers les aires principales de la ponte, situées dans les zones littorales d'Islande, on peut les rencontrer ici. Lors de la pêche horizontale de la surface au niveau de 100 m et au moment de l'éclosion générale des larves, on a révélé les différences des dimensions des individus habitant les différents horizons de la masse d'eau (Tableau 11).

Les recherches soviétiques ont ainsi complété d'une façon considérable nos connaissances concernant la ponte de harengs de printemps dans la région des Féroés. La ponte s'effectue non seulement dans l'isobathe des 50 m — ce sont les investigateurs danois qui le constate — mais aussi dans les régions beaucoup plus profondes. La majorité des harengs se reproduit dans des limites entre les isobathes des 100 m et des 200 m. La ponte atteint son climax à la seconde moitié du mois de mars et non pas au début de ce mois. La ponte de la race d'été du hareng n'a jamais lieu dans cette région.

I. G. Judanov

B. Near Northern Seas

YOUNG STAGES

Autumn Spawned Herring Larvae in the Northern North Sea

Scottish sampling of autumn spawned herring larvae in 1958 was carried out over the same area as in the preceding year. This area was covered in each of the following periods: 22.—30. August, 31. August—4. September, 8.—18. September, 14.—28. October, and 7.—22. January. Partial coverage of this area was also obtained during intervening periods and additional samples from the Shetland/Moray Firth region were obtained in September and November 1958 and in February 1959.

The outstanding feature of the first three main surveys was the scarcity of recently hatched larvae. Such larvae were obtained during this period in an area close to the coast between Buchanness and Kinnaird Head, and on Aberdeen, Montrose, Marr, and Berwick East banks, but in much smaller numbers than is normally encountered at this time. No small larvae at all were taken on Turbot Bank prior to 22. September. During this period larger larvae, ranging in length to 20 mm, were widely dispersed over the area to the west of 0°30′W but were completely absent east of this.

In the period 22.—23. September that part of the main station grid north of 57°N was repeated. Since this area had last been sampled, about ten days previously, the numbers of larvae present had increased about tenfold. It would seem unlikely that this could be accounted for by local hatching, as the increased abundance was almost entirely in the size group over 12 mm in length.

When the area was resampled, in the period 14.—28. October, hatching had ceased. Another marked increase in abundance of larvae was noticeable, however; the increase being most marked in those over 15 mm long. The distributional picture, which had until then remained remarkably stable, also showed a considerable change. The sharp eastern boundary, at about 0°30′W, had broken down, considerable numbers of larvae being found as far east as 1°30′E. Moreover, the main body, although still confined to the west of the prime

meridian, to the north of 57°N, showed an easterly shift of about 30 miles since the previous complete survey.

The last complete survey, in January 1959, revealed only scattered bodies of herring larvae, principally close to the Scottish coast, although two such bodies were also sampled between 1°E and 2°E.

Because of the peculiarities of the Scottish summer spawning fishery it was decided to supplement the normal sampling grid for larvae with additional sampling to the north of it as opportunity arose. One cruise, in the period 13.—16. September, covered the area between the east coasts of Orkney and Shetland and the prime meridian. These samples revealed an abundance of recently hatched herring larvae off the east coast of Orkney and off Clythness but none at all in the Fair Isle passage or to the east of Shetland. A comparison of the size frequency distribution of these larvae with that of larvae on a cruise at the same time on the more southerly spawning grounds showed clearly the preponderance of small larvae to the north and of those greater than 12 mm to the south.

The inner reaches of the Moray Firth were also sampled for herring larvae in November and again in February. These two surveys showed the progressive transport of a considerable body of larvae towards the approaches to the Inverness and Cromarty Firths; but the abundance of larvae in the Moray Firth was rather below that found in 1954 and 1955.

There were, then, four outstanding features of the distribution and abundance of herring larvae in 1958. Firstly, the level of larval production on the spawning grounds south of the Moray Firth was low even in comparison with 1957 which was itself a poor year. The shift towards the more southerly spawning banks from Turbot Bank, commented on in the report for 1957, was again in evidence. Secondly, there was evidence of a very heavy spawning on the grounds to the east of Orkney and off Clythness which would appear to have exceeded anything encountered in previous sampling of this area in the post-war period. The third feature of interest was the evidence for a considerable influx of larger larvae into the normal distributional area of the Buchan spawning in late September and in October, presumably from the Orkney region; bringing the abundance index of larvae in this region up to the 1957 level. Finally the sharp eastern boundary to the distribution maintained until late September broke down in October to give as wide a distribution to the east as in the preceding year.

A. Saville

COMMERCIAL FISH

Temperature Conditions and Herring Distribution on the Fladen Ground in the Period May/October 1958

(Figures 6–10)

In the period May/October 1958 the research vessels "Birkut" belonging to the Sea Fisheries Institute at Gdynia and the "Karl Liebknecht" belonging to the Institut für Hochseefischerei at Rostock carried out some cruises in the central and northern North Sea.

One of the purposes of these cruises, and of the common work done by the scientific teams of both the institutes, was to answer the question whether there existed any relation between the temperature conditions in the bottom water layers of the northern North Sea and the geographical distribution of the pre-spawning bank herring communities on the Fladen Ground. Therefore the whole area of the central and northern North Sea was covered with a dense network of hydrographic stations, the distance between which was 7.5 sea-miles on the Fladen Ground and 15 sea-miles in the other areas. The changes of the temperature conditions have been studied four times during the summer, especially with regard to the temperature of the bottom water.

To get a view about the distribution of the herring shoals, experimental catches of one hour's duration were made regularly and the whole area sampled was sounded continuously with the echograph. The results obtained have been plotted in Figures 6—10.

Temperature conditions of the bottom water

In May and June (Fig. 6) the greater part of the area investigated was showing very cold bottom water with temperatures below 6°C. Within this water mass the temperature decreased from north-west to south-east and had its minimum in the area of the Schlick Bank.

Especially noticeable were the horizontal temperature differences between the central and the northern part of the North Sea. The mass of cold bottom water in the northern North Sea was bordered in the west, north, and east by warmer

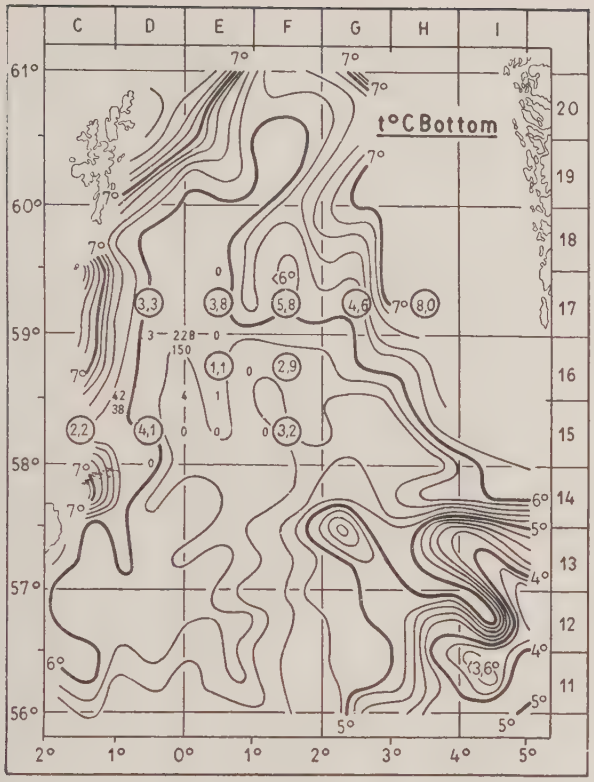

Figure 6.

Atlantic water. At the same time, in the central part of the North Sea a strong continental influence, in the form of an evident temperature decrease within the bottom water was remarkable from west to east.

On the Fladen Ground the mean temperature at the bottom, calculated from 25 stations was 5.72°C. The deviation from the long-term means (1900/1956) amounted to —0.75°C. Similar bottom water temperature conditions in the northern district were observed in 1924, 1937, 1947, 1955, and 1956 (Prahm, 1956).

These extraordinary low bottom water temperatures were obviously due to the long and severe winter of 1957/58, which gave rise to a noticeable drop in water temperature because of thermic convection.

In July (Fig. 7), the temperature of the bottom water had changed. The cold bottom water, with temperatures below 6°C, which formerly had its largest extension southward from 59°N had, notably, been narrowed from the west. This dislocation was greatest in the region of 57°45′N. There, the 6°C isotherm, having run in May/June along the meridian 1°W in a wedge shape, reached 1°30′E.

In August (Fig. 8), the splitting process had proceeded further. The wedge of warm water had changed its direction and, having turned towards north, two separated cores of cold bottom water with temperatures below 5.8°C had come into existence. One of those cold water cores could be observed north of the Fladen Ground, the other south-east of it.

In September (Fig. 9), the wedge of warm water, coming from south-west, had totally pushed through the cold bottom water. A separated small cold water core was found on the Fladen Ground, and a bigger one south-east of it. The causes of these processes occurring in the bottom water layers of the northern part of the North Sea were described by G. Dietrich (1955, 1957).

Herring distribution on the Fladen Ground

Experimental catches

The seasonal distribution of herring in the prespawning stage on the Fladen Ground in summer and autumn was gauged from experimental, one-hour trawl hauls made during every cruise. The herring distribution found in the different months is shown in Figures 6—9.

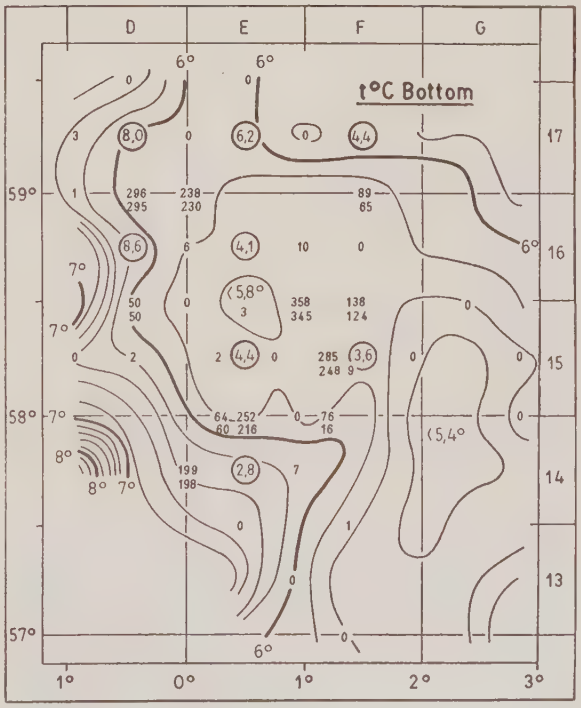

Figure 7.

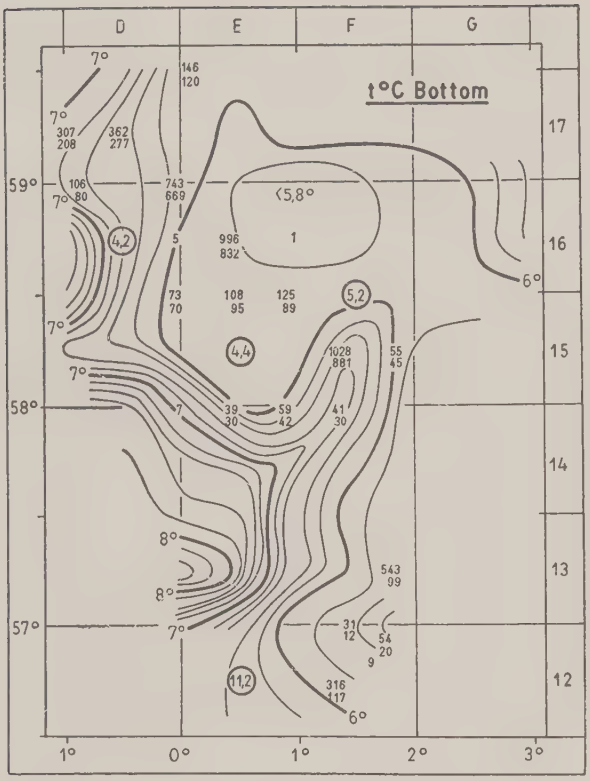

Figure 8.

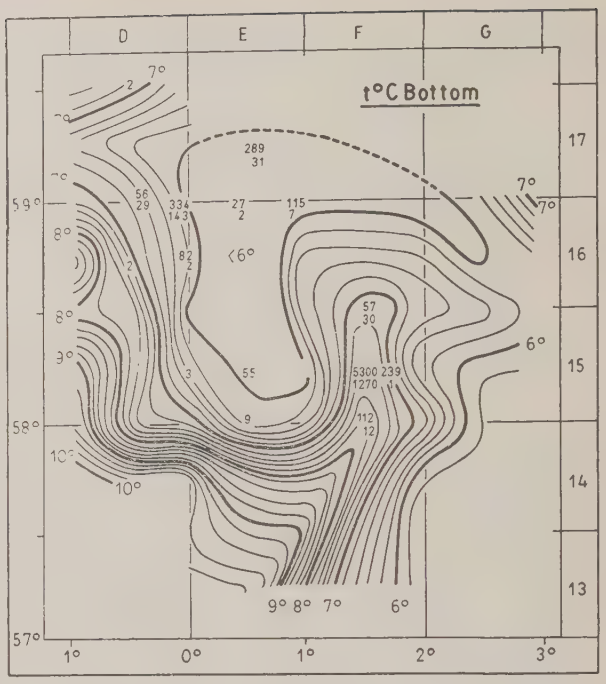

Figure 9.

The top numbers registered on the figures indicate the total yield of herring per hour, the lower ones denote the amount of pre-spawning herring contained in the same catch.

The biological investigation of the herring population and its racial composition has been performed by H. Schultz and J .Popiel. The values presented in Figure 6 illustrate the distribution of herring observed in the period 5.—15. June.

Small herring concentrations were encountered at that time in the area of the Fladen Ground Furrow and north-east of the Little Halibut Bank. In July (Fig. 7) the experimental catches taken in the area sampled yielded only small amounts. The best yields were obtained in the region of the Fladen Ground Furrow as well as in the central and south-eastern parts of the Fladen Ground and on the Witch Ground. Two trawl hauls made in the Gut showed that the herring were not yet concentrated at the bottom.

The yields per fishing hour in August (Fig. 8) were higher than those in July. Taking in account the advanced season they were too small indeed. The best catches were taken on the Dutch Bank and in the area of the Fladen Ground Furrow as well as in the north-western and south-eastern part of the Fladen Ground. In the Gut only poor or mediocre herring concentrations were found.

The experimental catches on the Fladen Ground in September (Fig. 9) generally gave small yields. In the comparatively dense fish concentrations on the south-eastern Fladen Ground, being the basis of an intensive fishery in that region during a short period, not only pre-spawning but also the juvenile herring were found in appreciable quantities. Adult spent herring were present in only small quantities.

On some fishing grounds, for example in the area of the Fladen Ground Furrow and on the north-western Fladen Ground, a noticeable rise in the density of herring took place up to August. After September, however, it diminished. An exception was the south-eastern Fladen Ground. In this area the density of pre-spawning herring continued to rise until the second half of September. At this time one experimental catch per one hour yielded 5,300 herring. The number of pre-spawning herring in this catch amounted to 1,270 herring. Two weeks later an experimental catch made in the same place gave 239 herring. Only one herring in the pre-spawning stage was found amongst them. That means that the pre-spawning herring had left this fishing ground in the meantime.

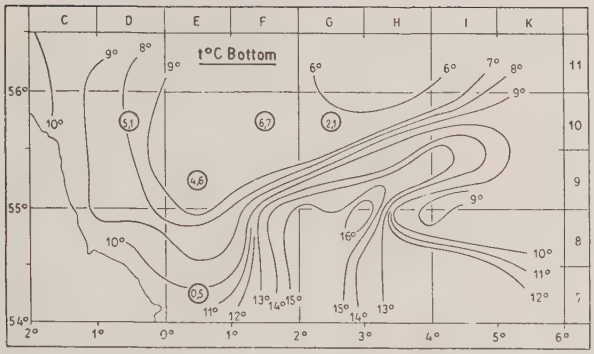

Figure 10.

Commercial catches

The numbers in circles in Figures 6—10 refer to the yield in metric tons per vessel and day of Polish trawlers. These values have been related to the fishing grounds, determined by means of the net of squares, according to the division adopted by the ICES.

The course of the catches

In the months May/June 1958 the trawlers were fishing in the area between 58° and 59°30′N, 1°W and 4°E. At that time the highest yields were obtained in the squares 15 D, 17 F, 17 B, and 17 H (see Fig. 6).

In July the maximal yields per fishing day were obtained in the squares 16 D, 17 D, 15 E, 17 E, and 17 F. In August the squares 12 E and 15 F gave the highest yields.

The results of the commercial catches showed that in May, June, and July the herring shoals were distinctly concentrated north of the Fladen Ground. The situation altered in August, when the most abundant catches were taken on the fishing grounds south of 57°N. This event grew still more evident in September and October, when nearly all the Polish vessels were grouped on the fishing grounds north of the Dogger Bank.

In the fishing area to the north of the Fladen Ground in May, June, and July the catches proceeded at a bottom water temperature oscillating around 6°C and generally not exceeding 7°C. In only one case was a catch of 8 tons (in square 17 H) taken within the 7°C isotherm.

The catches in September and October were taken in the area 7—9 E, 10 D, 10 F, and 10 G, where the bottom water temperature was within the limits 7—8°C. In this area, young, two year-old herring were mixed with varying proportions of herring in the pre-spawning and spent stages (Fig. 10), (J. Popiel, 1958).

Conclusions

The experimental catches did not show any distinct relation between the herring concentrations and the temperature conditions in the bottom water on the Fladen Ground. These results are contrary to the observations made by Schubert (1957) who encountered in August 1955 the densest concentrations of herring shoals in a core of cold bottom water.

In no month during the whole season did the experimental catches show a herring distribution which might be interpreted to be in any causal relation with the horizontal temperature differences in the bottom water. Rather, during the period of investigation, the pre-spawning herring appeared in more or less concentrated swarms in both the colder and warmer water.

In the south-eastern parts of the Fladen Ground the pre-spawning herring concentrations even increased in spite of a pronounced change of thermic conditions within the bottom water (Figs. 6—9).

The commercial catches showed that the herring concentrations took place at low but not lowest bottom water temperatures. However, having analysed only the material based upon the yields of the Polish trawlers, this relation is not safely established. Therefore it seems to be necessary to continue the observations in the coming seasons to ascertain if such a dependence of importance for the commercial fisheries exists.

J. Filarski, R. Schemainda

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Length, Age, and Spawning Groups of Norwegian Winter Herring in 1958

(Tables 12–14)

The migration of the herring schools was followed by the R/V "G. O. Sars" to the Norwegian coast in January 1958. On 24. January, shoals appeared in coastal waters off Runde and Svinøy south of Aalesund. Bad weather conditions hampered especially the purse seining through the season. The concentrations of herring south of Stad were small. A likely explanation of this fact is that cold Baltic water had reached Stad already in the middle of January.

Table 12. Length composition of Norwegian winter herring (‰) in 1958

A: Stages IV—VIII; B: Total (including stages I—III and herring with scales not fit for age determination)

	A		B	
Cm	Purse-seine	Drift-net	Purse-seine	Drift-net
18.5	—	—	0.5	—
19.0	—	—	—	—
.5	—	—	—	—
20.0	—	—	—	—
.5	—	—	0.5	—
21.0	—	—	—	—
.5	—	—	—	—
22.0	—	—	—	—
.5	—	—	—	—
23.0	—	—	—	—
.5	—	—	0.5	—
24.0	—	—	0.5	—
.5	—	—	0.5	—
25.0	—	—	0.5	—
.5	—	—	1	—
26.0	—	—	1	—
.5	—	—	1	—
27.0	1	0.5	3	1
.5	0.5	—	0.5	—
28.0	5	1	6	1
.5	4	0.5	5	1
29.0	14	2	16	3
.5	20	11	20	11
30.0	43	27	43	28
.5	42	33	41	32
31.0	76	70	73	68
.5	69	58	64	57
32.0	83	93	82	91
.5	98	101	94	95
33.0	133	140	124	133
.5	101	111	95	104
34.0	91	102	88	95
.5	55	63	54	60
35.0	42	48	42	58
.5	31	43	33	49
36.0	38	42	44	50
.5	26	29	31	30
37.0	18	18	22	24
.5	4	3	6	5
38.0	4	3	5	3
.5	1	1	1	1
39.0	0.5	—	1	—
.5	—	—	0.5	—
Total	1,000	1,000	1,000	1,000
Number	3,031	2,275	3,383	2,535

The total catch of the winter herring season was only 3,675,850 hectolitres; in 1957 it was 8,554,640 and in the season 1956 it was 12,321,064 hectolitres.

The length frequency, age distribution, and distribution of spawning groups are given in Tables 12—14. It will be seen that the 1950 year-class constituted about 57% of the total number in the samples. The low percentage of the younger year-classes indicates that the 1951, 1952, 1953, and 1954 year-classes are poor. Spawning group I still constituted 21% of the total number investigated, due to the fact that the mature stock in 1958 received a substantial number of recruit spawners from the 1950 year-class. We must regard the stock of Atlanto-Scandian herring as reduced during the year 1958, but the great decline in the output of the Norwegian winter herring fisheries is mainly caused by bad weather conditions and extremely cold surface water during the season.

Table 13. Age composition of Norwegian winter herring at maturity stages IV—VIII (‰)

	Purse-seine			Drift-net			
Age	N.type	S.type	Total	N.type	S.type	Total	Total
3	—	10	4	—	1	0.5	2
4	1	43	18	—	16	7	13
5	32	136	73	22	118	61	68
6	10	96	44	21	137	68	55
7	44	116	73	53	144	90	80
8	680	434	581	664	402	557	571
9	22	34	27	25	34	29	28
10	46	16	34	55	29	45	39
11	45	34	41	40	47	43	42
12	17	24	20	25	22	24	21
13	24	26	25	19	23	20	23
14	20	16	18	15	14	15	17
15	12	7	10	20	7	15	12
16	7	5	6	8	2	5	6
17	11	2	7	7	1	4	6
18	14	1	9	8	1	5	7
19	6	—	4	5	—	3	3
20	4	—	3	5	1	4	3
21	4	—	2	8	—	4	3
22	0.5	—	0.5	—	1	0.5	1
23	0.5	—	0.5	—	—	—	—
Total	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Number	1,800	1,199	2,999	1,332	921	2,253	5,252

Table 14. Distribution of spawning groups of Norwegian winter herring (‰) in 1958

Spawning groups	Purse-seine	Drift-net	Total
I	235	191	216
II	117	103	111
III	113	150	129
IV	226	240	232
V	145	154	149
VI	35	32	34
VII	23	28	25
VIII	22	28	25
IX	27	22	25
X	17	20	18
XI	11	10	10
XII	14	6	10
XIII	7	6	7
XIV	3	7	5
XV	4	2	3
XVI	0.5	0.5	0.5
XVII	0.5	—	—
XVIII	—	—	—
XIX	—	0.5	0.5
Total	1,000	1,000	1,000
Number	2,999	2,253	5,252

FINN DEVOLD

Survey of the German Commercial Herring Fisheries and the Biological Conditions of the Stocks

(Figures 11–14; Tables 15–22A)

A. The Fishery

The total herring landings from the German fishing fleet are recorded in Table 15. The total catch has decreased by 18.9%. 86.7% (208,000 tons) consisted of herring for human consumption, 13.3% of factory herring (32,000 tons). The decline is mainly due to the smaller catches of the trawlers (18.9%) and trawl-luggers (6.2%) in the summer season (32,000 tons). However, the deep-sea cutters showed an increase by 25% as the result of larger factory herring catches.

1. Herring trawlers

The catch of the trawlers in the North Sea decreased by 25.8% (33,000 tons), the number of trips fell off from 1,174 to 1,082 (7.8%), the catch per day's fishing from 12.7 to 9.6 tons.

(a) The *spring fishery* was centred on the Viking Bank, in the Utsira region ("Ostkante") from January to June. The total landings of this season amounted to 20,376 tons (+104.4%). 245 trips were made as compared with 230 in 1957. The catch per day's fishing increased from 3.3 tons to 8.7 tons. The increased yield was the result of an increased fish density in March.

(b) The *summer/autumn fishery* started on the Fladen Ground area about 15. June and was carried on for 128 days. However, the main fishing was from the middle of July to the middle of September. From 7.—15. December some boats were fishing once more in this area. To the Fladen area 560 trips (596 in 1957) were made. The total yield decreased from 76,023 tons to 48,646 tons (36.0%). Also the catch per day's fishing decreased from 15.5 tons to 9.7 tons. The decreased yield was mainly affected by the hydrographical situation in July/August in this area.

The fishery on the Gut was of no importance in 1958. Only 8 trips against 43 were made from the middle of August to the middle of September. The total yield dropped from 5,176 tons to 476 tons as the result of reduced effort. The catch per day's fishing decreased from 13.9 tons to 8.3 tons.

In the Dogger Bank area fishing started in mid-August and lasted until the beginning of November. The number of trips declined from 273 to 215. The total yield decreased from 32,641 tons to 22,697 tons (–30.5%), the catch per day from 17.7 tons to 12.2 tons.

The total yield of the trawl fleet on the customary fishing places in the summer/autumn fishery showed a decline from 113,840 tons to 71,819 tons (–38.9%).

(c) In the *Channel fishery* in November/December 107 trips were made against 231. The total yield decreased from 17,563 tons to 6,791 tons (–61.3%), the catch per day's fishing from 9.5 tons to 8.0 tons.

The main catch came in November from the Sandettié area. 4,655 tons against 6,800 tons were caught (–31.5%). The catch per day was 14.4 tons against 9.8 tons. The fishing in the Dieppe and Boulogne area in December was a failure. Only 723 tons came from Dieppe and 755 tons from Boulogne. The catch per day amounted to 2.8 tons and 2.7 tons respectively.

Six trips were made in December to Eddystone. The total yield was 21 tons.

(d) As the result of reduced yields on the southern fishing grounds, the trawlers searched new places. From January to February and in December they were fishing in the Dunmore area. 97 trips yielded 10,387 tons. The bulk of the catch was made in January; 63 trips yielded 8,778 tons. In February only 755 tons were caught in 13 trips.

Table 15. Total herring landings (in 1000 tons) of the German fishing fleet in 1958

	North Sea	Channel	W of Gr. Britain	Other Areas	Total
Trawlers	95 (128)	7 (19)	18 (1)	+ (+)	120 (148)
Drifters	67 (67)	3 (6)	+ (—)	— (—)	70 (73)
Fresh herring	10 (9)	— (—)	— (—)	— (—)	10 (9)
Drift-net	3 (6)	— (—)	— (—)	— (—)	3 (6)
Trawl	7 (3)	— (—)	— (—)	— (—)	7 (3)
Salt herring	57 (58)	3 (6)	+ (—)	— (—)	60 (64)
Drift-net	45 (40)	3 (6)	+ (—)	— (—)	48 (46)
Trawl	12 (18)	+ (+)	+ (—)	— (—)	12 (18)
Deep-sea cutters	32 (23)	— (+)	— (—)	18 (17)	50 (40)
for consumption	2 (2)	— (+)	— (—)	16*) (15)	18 (17)
for factories	30 (21)	— (—)	— (—)	2*) (2)	32 (23)
Total	194 (218)	10 (26)	18 (1)	18 (17)	240 (262)

( ) = 1957; *) = Baltic/Kattegat/Skagerak

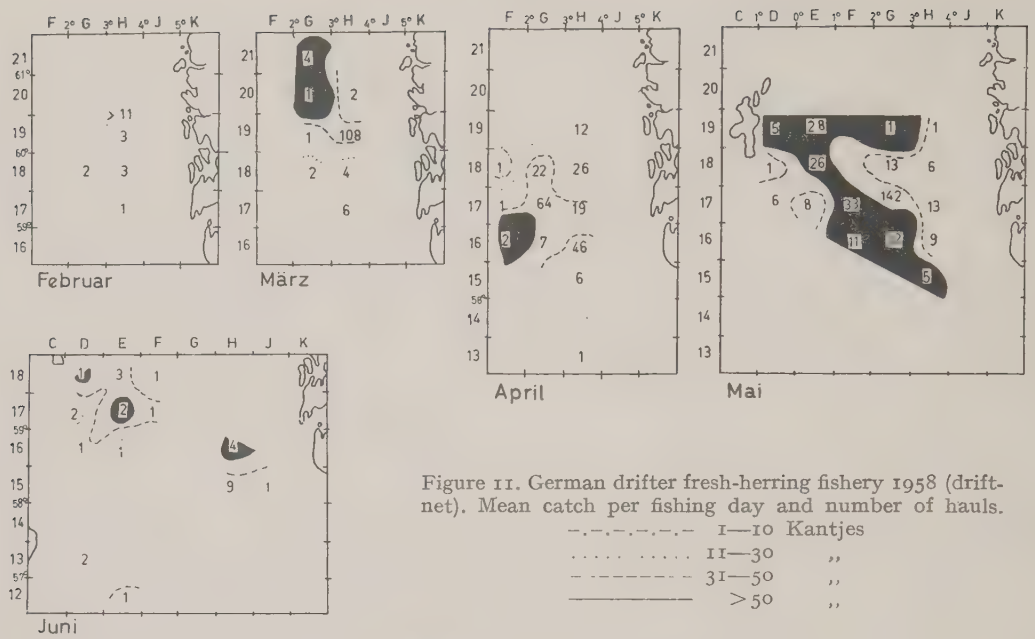

Figure 11. German drifter fresh-herring fishery 1958 (drift-net). Mean catch per fishing day and number of hauls.

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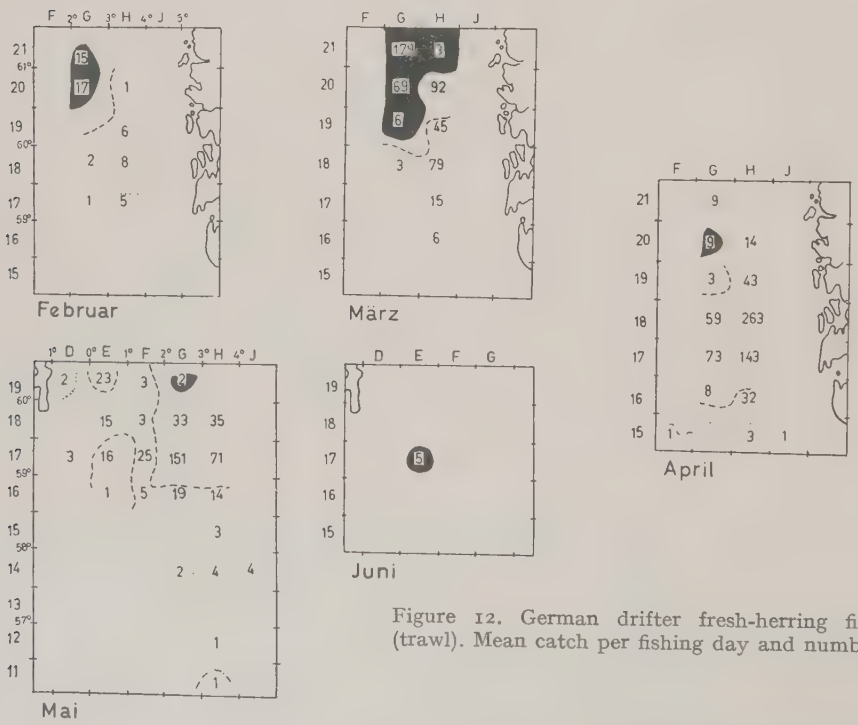


Figure 12. German drifter fresh-herring fishery 1958 (trawl). Mean catch per fishing day and number of hauls.

The catch per day amounted to 18.7 tons, respectively 5.7 tons. The catch in December yielded in 46 trips 854 tons. The catch per day was only 2.1 tons.

From February to April and in June and October some trawlers were fishing north of Ireland (Klondyke to Stanton Bank). The total yield in this time was 856 tons in 13 trips. The catch per day's fishing was in January 16.4 tons, in the other months between 4.0 tons and 8.2 tons. However, in November in 63 trips 5,663 tons were caught. The catch per day was 12.3 tons.

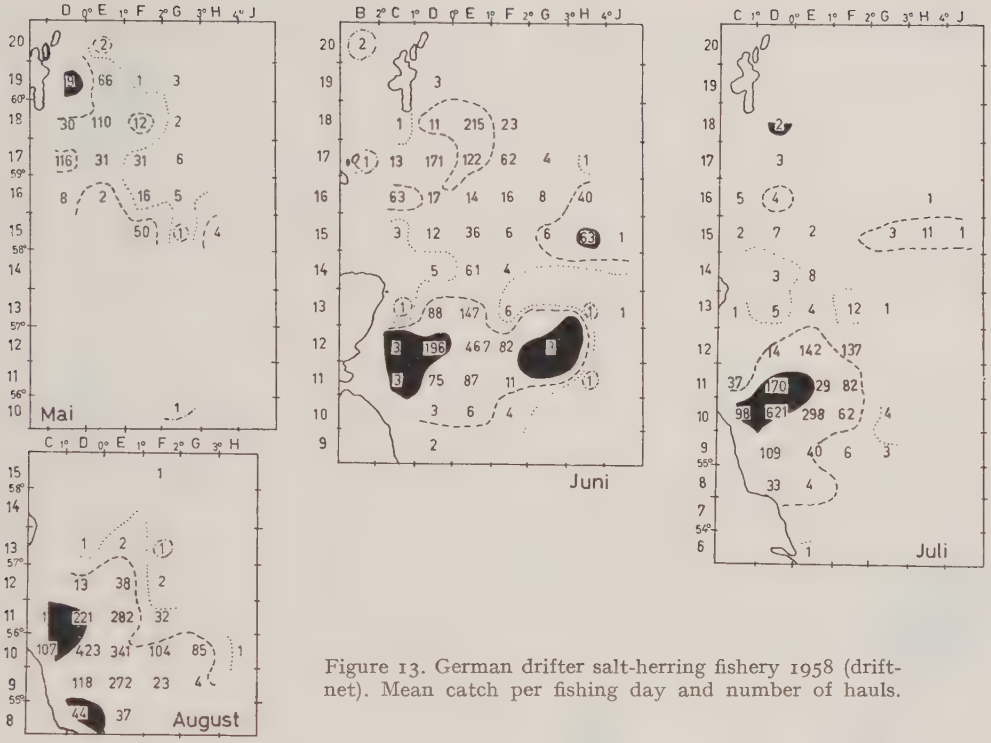
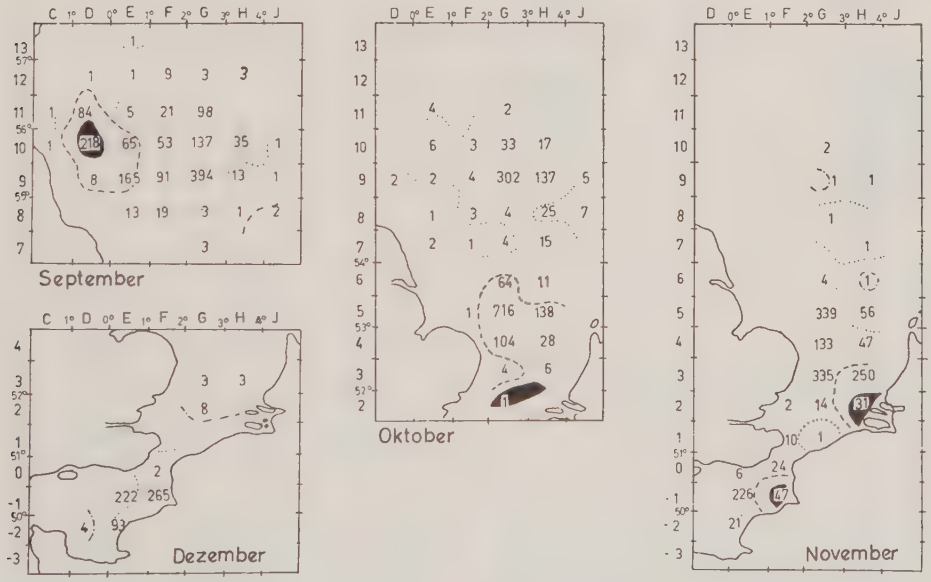


Figure 13. German drifter salt-herring fishery 1958 (drift-net). Mean catch per fishing day and number of hauls.



In August 13 landings came from the North Minch area with a yield of 5,663 tons. The catch per day was 17.4 tons.

As in the year before the trawlers started a fishery from October to December on the "Ostkante". 2,382 tons were caught on 54 trips. The catch per day increased from 5.6 tons to 6.8 tons.

2. Drifters

The total yield of the fleet declined from 75,134 tons to 73,409 tons. The catch in the North Sea was the same as in 1957 (67,000 tons). However, the catch in the Channel decreased from 6,595 tons to 3,071 tons.

In the fresh herring season from February to

Figure 14. German drifter salt-herring fishery 1958 (trawl). Mean catch per fishing day and number of hauls.

June 226 trips against 219 were made. The total yield increased from 9,287 tons to 9,788 tons (5%). 2,906 tons were fished with drift-nets (29.7% of the total catch), and with the trawl 6,882 tons (70.3%). The trawl catches were from February to May better than the year before. The catch per day's fishing was 3.8—4.7 tons against 2.2—3.1 tons. However, the drift-net showed a decline from 3.9 to 5.2 tons to 0.9—4.4 tons.

Figures 11 and 12 show the monthly distribution of the mean catch and the number of shots for the drift-net and the trawl.

From the North Sea 56,635 tons against 57,408 tons in 1957 of salted herring were landed from May to December. The number of trips increased from 582 to 591, only 20% of these herring were caught by trawl. The catch per day decreased from 4.4 tons to 3.7 tons (drift-net) and from 5.9 tons to 4.4 tons (trawl).

Figures 13 and 14 show the monthly distribution

of the mean catch and the number of shots for the drift-net and trawl for the salt herring fishery.

On the Fladen Ground the catch dropped from 18,785 tons to 7,589 tons (59.6%). The decreased yield is mainly the result of the diminished trawl catch, which was heavily influenced by the hydrographical situation in July/August. However, the catch per day showed also a decrease from 3.6 tons to 2.9 tons (drift-net) and from 5.8 tons to 4.3 tons (trawl).

On the Gut the total yield increased from 8,591 tons to 15,824 tons. The rise resulted from an increased drift-net fishery (+259%). However, the trawl showed with 2,842 tons a decrease of 19.4%. The catch per day increased from 3.7 tons to 4.3 tons for the drift-net, while the trawl decreased from 5.4 tons to 4.3 tons.

In the Dogger Bank area the yield increased from 14,406 tons to 22,323 tons (55%) as the result of increased effort, mainly by drift-net. The catch per day decreased from 4.6 tons to 3.8 tons (drift-net) and from 4.5 to 4.0 tons (trawl).

Fishing in the Southern Bight ("Binnensee") showed a decrease from 10,734 tons to 9,762 tons (9.1%). The catch per day declined from 5.4 tons to 3.2 tons (drift-net).

In the Channel the number of fishing days decreased from 2,329 to 1,513, the total catch from 6,595 tons to 3,071 tons (53.3%). The catch per day declined from 3.2 tons to 2.3 tons (drift-net) and from 3.8 tons to 1.5 tons (trawl).

In December 8 landings came for the first time from the Dunmore area. The total catch was 486 tons. The catch per day's fishing was 2.4 tons (drift-net) and 2.3 tons (trawl).

3. Cutters

The total yield of herring for human consumption from the deep-sea and coastal cutters in the North Sea decreased from 2,424 tons to 1,964.5 tons. The deep-sea cutters made only 11 trips against 15 in 1957. The total output fell from 178 tons to 94.3 tons, the catch per trip decreased from 11.9 tons to 8.6 tons.

The total catch of the "oil" herring fishery increased by 73.2%, the yield rose from 17,087 tons to 29,594.2 tons, the total number of trips fell from 902 to 846.

Table 16. Length composition of all samples (‰)

Gear	Trawl				Trawl	Drift-net	Trawl	Drift-net	Trawl	Trawl				
Area	Viking Bank/Utsira				Bressay Shoal					Fladen Ground				
Samples	Market	Market	Market	Market	Market	Market	Market	Market	Market	Market	Market	Market	Market	Market
Month	II	III	IV	V	V	V	VI	VI	VIII	VI	VII	VIII	IX	X
cm 39	1	—	—	—	—	—	—	—	—	—	—	—	—	—
38	3	6	—	—	—	—	—	—	—	—	—	—	—	—
37	19	42	1	5	—	1	—	—	—	—	—	—	—	—
36	70	95	3	10	—	—	—	—	—	—	—	2	—	—
35	58	119	8	10	6	1	—	—	—	—	—	—	—	—
34	55	86	18	35	18	—	—	—	—	—	1	—	2	—
33	81	100	45	37	53	3	—	2	30	—	—	2	15	—
32	98	126	86	95	173	12	4	16	160	2	1	2	67	—
31	112	100	141	128	232	43	9	54	180	21	6	16	181	2
30	165	126	224	235	167	88	19	88	270	102	53	92	143	16
29	135	101	161	199	101	162	89	156	260	168	137	205	133	60
28	75	51	106	105	161	209	155	195	120	234	239	252	108	102
27	55	28	74	82	53	200	148	197	40	204	257	249	131	129
26	30	14	58	45	24	170	244	152	—	177	216	135	85	148
25	28	4	47	12	12	82	253	111	—	77	83	41	43	160
24	7	2	21	2	—	27	70	23	—	15	7	2	23	137
23	5	—	5	—	—	2	9	6	—	—	—	—	17	110
22	3	—	1	—	—	—	—	—	—	—	—	—	20	86
21	—	—	1	—	—	—	—	—	—	—	—	—	17	38
20	—	—	—	—	—	—	—	—	—	—	—	2	10	12
19	—	—	—	—	—	—	—	—	—	—	—	—	5	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	1084	1237	1431	401	168	920	528	514	100	1083	2008	599	601	499
Av. length, cm	31.33	32.62	29.86	30.30	30.60	28.15	26.95	28.11	30.35	28.10	27.80	28.30	29.18	25.72
Males ‰	445	478	458	450	530	440	500	420	460	450	523	535	387	390

B. The Herring Stock

Eighty-six samples comprising 41,962 herring were investigated and the main results are given in Tables 16—22.

1. Viking Bank/Utsira

Nine samples were examined from February to May. The average sizes of the herring in the different months were 29.86 to 32.62 cm (Table 16). It appears from Table 17 that maturity stage V was predominant in February and March, whereas stages VII/II and II were most frequent in April and May. The age composition of the catches (Table 18) indicates that in February the 8 and more than 10 year-old fish were predominant (483‰), in March the more than 10, 8, and 6 year-old fish were most abundant (763‰), in April the 8, 6, and 5 year-old (718‰), and in May the 8, 5, 6, and more than 10 year-old herring (705‰). The total number of vertebrae (V.S.) is given in Table 19 showing the average counts of 57.09, 57.02, 57.12, and 56.79. The average number of vertebrae (V.S.) (Table 20), the average number of keeled scales (K_2) (Table 21), and the average number of gill rakers in relation to maturity stages (Table 22) indicate that from February/April the Atlantic late winter spawners were predominant in the catches, while in May the catches were a mixture of North Sea autumn spawners and late winter spawners.

2. Bressay/Fladen Ground

From this area 15 samples containing 7,020 herring were investigated. The average length in the Bressay area in May and August was 30.60 and 30.35 cm, in July 26.95 cm. On the Fladen Ground from June to September 27.80 to 29.18 cm, whereas in October the average length decreased to 25.72 cm (Table 16). The maturity was advancing from May to September. In May/June stages II/III were predominant in boths areas. On the Fladen Ground stages III/V were abundant in July, in August stages V/VI, whereas in the Bressay area during this period stages IV, III, II, VII were more frequent. On the Fladen Ground in September stages III, VII and IV, and in October, VII and VI were predominant (Table 17).

Table 16 (continued)

Gear	Trawl	Trawl	Trawl	Trawl	Trawl		Pelagic Trawl			Trawl		Trawl		
Area	North Minch	Firth of Forth	Long Forties	Gut	Dogger Bank		SW of Egersund		Skagerak	Sandettié		East of Dogger		
Samples	Market	Sea	Sea	Sea	Market	Sea	Sea	Sea	Sea	Market	Market	Market	Market	Sea
Month	VIII	VI	VI	X	IX	X	XI	XII	XII	XI	VII	VIII	IX	X
cm 37	—	—	—	—	—	—	—	4	-	-	—	-	-	—
36	—	—	—	-	-	—		—	—	—	—	—	-	—
35	—	—	—	—	—	—	2	4	—	—	—	—	—	—
34	—	—	—	—	—	—	9	11	—		—	—	—	—
33	3	—	—	—	—	—	7	40	1	—	-	—	—	—
32	3	—	—	1	1	1	23	112	1	—	-	—	-	—
31	36	—	—	5	3	10	64	**250**	6	—	—	—	—	—
30	78	—	—	11	6	30	107	205	2	13	—	—	—	—
29	148	1	—	17	31	34	134	127	6	23	—	—	—	—
28	212	1	20	20	50	24	134	85	15	90	—	—	—	1
27	**288**	—	50	28	61	29	**196**	66	11	87	—	—	1	1
26	206	8	170	31	65	41	68	32	8	160	—	—	3	3
25	23	10	**250**	45	76	60	32	13	41	173	—	3	15	3
24	3	26	240	102	111	96	52	17	135	**228**	—	9	50	7
23	—	89	180	207	163	132	**70**	11	**268**	160	—	32	67	7
22	—	**242**	75	**235**	**191**	**153**	59	8	252	60	6	68	118	12
21	—	219	15	188	145	131	34	9	156	6	39	100	157	16
20	—	149	—	92	62	108	9	6	59	—	188	129	144	53
19	—	87	—	16	26	91	—	—	25	—	**416**	**137**	**162**	131
18	—	93	—	2	6	45	—	—	13	—	248	133	118	**301**
17	—	42	—	—	3	11	—	—	1	—	97	**203**	**129**	206
16	—	28	—	—	—	3	—	—	—	—	6	157	31	112
15	—	3	—	—	—	1	—	—	—	—	—	29	—	31
14	—	1	—	—	—	—	—	—	—	—	—	—	4	26
13	—	1		—	—	—	—	—	—	—	—	—	1	27
12	—	—	—	—	—	—	—	—	—	—	—	—	—	54
11	—	—	—	—	—	—	—	—	—	-	-	—	-	9
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	344	778	200	3135	1563	12,350	440	527	893	300	154	1330	745	2734
Av. length, cm	28.15	21.15	24.95	23.27	23.75	23.15	27.73	30.11	23.06	25.51	18.72	19.10	19.95	17.31
Males ‰	460	363	505	462	427	420	520	459	427	470	—	—	—	219

The age composition (Table 18) shows the predominance of the 7, 9, and 6 year-old herring (739‰) in May in the Bressay area. In June the 4, 5, and 6 year-old herring were abundant in both areas (794‰ respectively 582‰). Also in July these year-classes were present on the Fladen Ground (819‰). In August the 6, 8, and 4 year-old herring were predominant in the Bressay area (593‰), while on the Fladen Ground from August to October only the 4 and 6 year-old fish were more frequent (695‰, 439‰, 555‰).

The average number of vertebrae found was 56.43—56.90 (Table 19), whereas the average in the Bressay area was markedly higher in May and August (56.90, 56.86). In September this number increased (56.76) also on the Fladen.

The different meristic characters in relation to maturity stages (Tables 20—22) show that in May in the Bressay area herring at maturity stage II consisted of a mixture of late winter spawners and autumn spawners, whereas fish at stage VII/II were late winter spawners. In the Bressay area in June the fish at stage II were a mixture of autumn spawners and late winter spawners, stages II and III were autumn spawners. On the Fladen in this month herring at stages I and II were late winter spawners, while stages III and IV were autumn spawners. Also in July the stages I and VII/II in these areas were late winter spawners, whereas stage II was composed of autumn and late winter spawners. Stages III to V were autumn spawners. In August stage I fish were late winter spawners in both areas, while in the Bressay area stage II fish were also of the late winter spawning type, the herring on the Fladen Ground was a mixture. Stages III to V in both areas were autumn spawners and also stage VII/II on Bressay. Stages I to III in September on the Fladen were a mixture of both types, IV, V, and VII/II were autumn spawners. In October autumn spawners were predominant in this area.

3. North Minch

One sample with 344 herring was examined in August. The average length was 28.15 cm (Table 16). The maturity stages IV and V were predomi-

Table 16 (continued)

Gear	Trawl			Trawl		Trawl		
Area	German Bight			South Ireland		North Ireland (Klondyke)		
Samples	Market	Sea	Market	Market	Market	Market	Market	Market
Month	III	VI	XII	I	II	III	VI	XI
cm 35	—	—	—	—	—	—	2	—
34	—	—	—	—	—	—	11	10
33	—	—	—	1	—	4	73	50
32	—	—	—	—	—	16	**154**	90
31	—	—	—	6	—	35	114	120
30	10	—	—	15	13	109	178	**310**
29	—	—	—	62	123	**268**	**200**	200
28	10	—	—	181	**270**	220	130	170
27	60	—	—	**202**	224	88	68	40
26	80	—	—	135	158	75	34	10
25	80	—	—	109	106	70	34	—
24	120	—	—	93	50	78	2	—
23	**320**	—	—	**122**	44	25	—	—
22	210	—	—	63	12	10	—	—
21	60	—	—	10	—	2	—	—
20	20	—	—	1	—	—	—	—
19	20	—	—	—	—	—	—	—
18	10	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—
16	—	10	—	—	—	—	—	—
15	—	103	—	—	—	—	—	—
14	—	**434**	10	—	—	—	—	—
13	—	404	120	—	—	—	—	—
12	—	49	**410**	—	—	—	—	—
11	—	—	320	—	—	—	—	—
10	—	—	120	—	—	—	—	—
9	—	—	20	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000
Number	100	309	100	1091	519	459	439	100
Av. length, cm	23.86	14.12	12.02	26.38	27.30	28.23	30.21	30.29
Males ‰	430	—	—	540	530	520	450	510

Table 17. Sexual maturity in all samples (‰) (trawl)

Area	Viking Bank/Utsira				Bressay Shoal			Fladen Ground					North Minch
Month	II	III	IV	V	V	VI	VIII	VI	VII	VIII	IX	X	VIII
Stages I	—	—	13	—	—	—	—	40	3	10	119	120	40
II	5	—	137	**820**	**800**	150	190	260	69	50	128	80	40
III	—	—	7	—	—	**740**	300	**580**	314	—	**306**	40	50
IV	50	—	7	—	—	110	**320**	120	**357**	54	220	130	340
V	**865**	**856**	20	—	—	—	60	—	254	**648**	10	100	**420**
VI	80	77	20	—	—	—	—	—	—	191	—	170	—
VII	—	64	237	50	—	—	130	—	—	—	—	30	—
VII/II	—	3	**559**	130	200	—	—	—	3	47	217	**330**	110
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	200	299	299	100	100	100	100	100	378	299	295	100	100

Area	Firth of Forth	Long Forties	Gut	Dogger Bank		SW of Egersund		Skagerak	Sandettié	East of Dogger		
Month	VI	VI	X	IX	X	XI	XII	XII	XI	VIII	IX	X
Stages I	**761**	60	**732**	**347**	**541**	254	87	**950**	—	**920**	**1000**	**980**
II	199	**365**	51	17	72	254	**295**	35	—	30	—	—
III	20	345	4	133	8	—	126	—	—	35	—	2
IV	10	35	9	170	27	40	202	5	—	15	—	14
V	—	5	5	200	26	40	71	—	97	—	—	—
VI	10	5	5	133	186	—	—	—	**893**	—	—	—
VII	—	65	36	—	70	20	55	—	10	—	—	—
VII/II	—	120	158	—	70	**392**	164	10	—	—	—	4
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	201	200	744	300	1935	102	183	199	300	200	99	492

Area	German Bight			South Ireland		North Ireland (Klondyke)		
Month	III	VI	XII	I	II	III	VI	XI
Stages I	130	**1000**	**1000**	—	10	—	—	—
II	320	—	—	—	100	40	**710**	120
III	—	—	—	—	—	—	—	50
IV	—	—	—	—	—	—	—	330
V	10	—	—	27	10	—	—	130
VI	—	—	—	**950**	—	20	—	—
VII	10	—	—	20	250	**830**	—	—
VII/II	**530**	—	—	3	**630**	110	290	**370**
Total	1000	1000	1000	1000	1000	1000	1000	1000
Number	100	195	100	300	100	100	100	100

nant (760‰) (Table 17). The 4 year-old herring (545‰) were the most abundant year-class. Some importance had still only the 5 and 6 year-old herring (294‰) (Table 18).

The average number of vertebrae was 56.52 (Table 19). According to the different meristic characters (Tables 20—22) the herring at stages I and II were late winter spawners whereas fish at stages III, IV, V, and VII/II were autumn spawners, distinguishable by their K_2 and gill rakers from the North Sea Bank herring.

4. Long Forties, Gut

Nine samples comprising 3,335 fish were investigated in June and October. The average length in the Long Forties in June was 24.95 cm, in the Gut in October 23.27 cm (Table 16). Maturity stages II and III were predominant (710‰) in June, and stage I (732‰) in October (Table 17). In the Long Forties only 4 year-classes (3—6) were present, the most abundant year-class was the 4 year-olds (Table 18). The average number of vertebrae was 56.69 in the Long Forties and 56.56 in the Gut (Table 19). The meristic characters in relation to maturity stages show that the autumn spawners were predominant in June in this area. In the Gut area stages II-VII/II fish were autumn spawners while stage I seems to contain a small proportion of late winter spawners (Tables 20—22).

5. Firth of Forth

In June, two samples (778 herring) from an area near the Firth of Forth were examined. The average length was 21.15 cm (Table 16). Maturity

Table 18. Age composition of all samples (‰) (trawl)

Area		Viking Bank/Utsira				Bressay Shoal			Fladen Ground					North Minch
Month		II	III	IV	V	V	VI	VIII	VI	VII	VIII	IX	X	VIII
Year-class	Age													
1957	1	—	—	—	—	—	—	—	—	—	—	—	—	—
1956	2	—	—	—	—	—	—	—	—	—	3	**111**	112	—
1955	3	10	11	7	73	—	31	—	—	8	17	70	172	51
1954	4	36	22	96	53	33	**454**	**140**	132	**354**	**348**	**251**	**314**	**545**
1953	5	114	32	144	**199**	141	175	93	205	211	85	157	71	152
1952	6	118	**104**	**147**	169	239	165	**244**	**245**	**254**	**347**	**188**	**241**	142
1951	7	140	82	93	74	**261**	52	81	61	103	88	84	40	40
1950	8	**322**	**204**	**427**	**210**	54	62	**209**	112	29	54	56	10	20
1949	9	57	29	18	63	**239**	10	58	82	21	17	49	—	30
1948	10	42	61	29	32	11	10	58	51	10	17	14	10	10
<1948	>10	**161**	**455**	39	**127**	22	41	**117**	**112**	10	24	20	30	10
Total		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number		192	279	279	95	92	97	86	98	374	294	287	99	99

Area		Firth of Forth	Long Forties	Gut	Dogger Bank		SW of Egersund		Skagerak	Sandettié	East of Dogger		
Month		VI	VI	X	IX	X	XI	XII	XII	XI	VIII	IX	X
Year-class	Age												
1957	1	—	—	—	—	3	—	—	—	—	—	—	301
1956	2	354	—	**736**	**344**	**543**	**240**	**94**	**945**	—	**892**	**1000**	**670**
1955	3	**545**	218	69	283	208	30	35	—	**454**	108	—	23
1954	4	76	**615**	73	154	61	**300**	**159**	30	308	—	—	6
1953	5	20	152	22	43	29	70	88	10	119	—	—	—
1952	6	5	15	**53**	**158**	**37**	**130**	**177**	—	44	—	—	—
1951	7	—	—	16	18	21	40	35	—	31	—	—	—
1950	8	—	—	3	—	19	**90**	88	—	31	—	—	—
1949	9	—	—	7	—	22	30	**206**	5	7	—	—	—
1948	10	—	—	6	—	14	10	6	5	3	—	—	—
<1948	>10	—	—	15	—	**53**	**60**	**112**	5	3	—	—	—
Total		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number		198	197	682	279	1914	100	170	200	295	194	99	482

Area		German Bight			South Ireland		North Ireland (Klondyke)		
Month		III	VI	XII	I	II	III	VI	XI
Year-class	Age								
1957	1	—	**1000**	**1000**	—	—	—	—	—
1956	2	181	—	—	—	—	—	—	—
1955	3	**577**	—	—	—	—	12	10	11
1954	4	121	—	—	**346**	54	**175**	153	134
1953	5	81	—	—	212	**258**	63	153	**244**
1952	6	30	—	—	32	97	**275**	**194**	211
1951	7	—	—	—	**193**	**290**	200	174	178
1950	8	—	—	—	74	97	88	51	134
1949	9	10	—	—	67	**107**	50	61	22
1948	10	—	—	—	45	97	25	**122**	44
<1948	>10	—	—	—	31	—	**112**	82	22
Total		1000	1000	1000	1000	1000	1000	1000	1000
Number		99	309	100	269	93	80	98	90

stage I (761‰) was predominant (Table 17). The 2 and 3 year-olds (899‰) were the most abundant (Table 18). According to their meristic characters they belonged to the autumn spawners.

6. Dogger Bank area

From this area 22 samples containing 13,913 fish were investigated in September and October. The average length was 23.75, respectively 23.15 cm

Table 19. Total number of vertebrae (V.S.) (‰)

Area	Viking Bank/Utsira				Bressay Shoal			Fladen Ground					North Minch
Month	II	III	IV	V	V	VI	VIII	VI	VII	VIII	IX	X	VIII
V.S. 60	—	—	—	—	—	—	—	—	—	—	3	—	—
59	10	10	7	—	10	10	—	10	3	—	7	—	—
58	199	158	241	140	102	42	150	91	42	41	100	70	51
57	664	678	628	540	664	479	580	424	478	425	554	465	469
56	122	151	117	290	224	427	250	404	448	486	308	445	429
55	5	3	7	30	—	42	20	71	29	48	28	20	51
54		—		—	—		—	—	—			—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	196	298	298	100	98	96	100	99	377	294	289	99	98
Av. V.S.	57.09	57.02	57.12	56.79	56.90	56.55	56.86	56.57	56.54	56.47	56.76	56.43	56.52

Area	Firth of Forth	Long Forties	Gut	Dogger Bank		SW of Egersund		Skagerak	Sandettié	East of Dogger		
Month	VI	VI	X	IX	X	XI	XII	XII	XI	VIII	IX	X
V.S. 60	—	—	—	—	—	—	—	—	—	—	—	—
59	10	—	3	7	2	—	—	5	—	—	—	4
58	87	76	50	54	50	63	111	41	51	20	30	36
57	498	549	474	453	483	458	556	452	497	451	455	415
56	379	360	452	429	437	458	322	477	408	514	445	495
55	26	15	18	44	25	21	11	25	41	15	70	46
54	—	—	3	13	3	—	—	—	3	—	—	4
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	195	197	684	298	1804	96	180	197	294	197	99	477
Av. V.S.	56.68	56.69	56.56	56.52	56.56	56.56	56.78	56.52	56.55	56.48	56.44	56.44

Area	German Bight			South Ireland		North Ireland (Klondyke)		
Month	III	VI	XII	I	II	III	VI	XI
V.S. 60	—	—	—	—	—	—	—	—
59	—	—	—	3	—	—	10	—
58	63	118	42	158	120	10	121	140
57	432	374	458	654	700	115	556	490
56	400	467	469	182	150	531	303	330
55	84	41	31	3	20	313	10	40
54	21	—	—	—	10	31	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000
Number	95	195	94	298	100	96	99	100
Av. V.S.	56.43	56.57	56.51	56.98	56.90	56.76	56.82	56.73

(Table 16). Maturity stages I (347‰) and III to VI (636‰) were predominant in September, while stages I (541‰) and VI (186‰) were abundant in October (Table 17). The 2 year-old fish were predominant in September and October with 344‰, respectively 543‰, and next in abundance were the 3 year-old herring in both months, while in September the 4 and 6 year-olds had some importance (Table 18). The average number of vertebrae was 56.52 and 56.56 (Table 19). Autumn spawners of the Bank herring type were those in maturity stages V—VII and II, while stages III—IV were a mixture of the Bank and Downs groups. However, fish at maturity stage I which were present in abundance north and north-west of the Dogger Bank seem to belong to an autumn spawning group from the north-west of the North Sea (North Minch?) (Tables 20—22).

7. The Channel

Only 3 samples comprising 300 fish were investigated in November from the Sandettié area. The average length was 25.51 cm (Table 16). Maturity stage VI was predominant (893‰) (Table 17). The 3 and 4 year-old fish (454‰, 308‰) were the important year-classes (Table 18). The average number of vertebrae was 56.55 (Table 19). The bulk of the catch belonged to the Downs group (Tables 20—22).

Table 20. Total number of vertebrae (V.S.) in relation to stages of maturity

Area	Viking Bank/Utsira								Bressay Shoal					
Month	II		III		IV		V		V		VI		VIII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	1	57.00	4	57.00	—	—	—	—	—	—	—	—
II	1	57.00	—	—	41	57.17	82	56.70	78	56.83	15	56.93	19	57.16
III	—	—	—	—	2	57.50	—	—	—	—	70	56.50	30	56.97
IV	10	56.90	—	—	2	57.50	—	—	—	—	11	56.36	32	56.81
V	169	57.09	255	56.99	6	56.67	—	—	—	—	—	—	6	56.17
VI	16	57.13	22	57.18	6	57.33	—	—	—	—	—	—	—	—
VII	—	—	19	57.16	71	57.10	5	57.20	—	—	—	—	—	—
VII/II	—	—	1	58.00	166	57.13	13	57.23	20	57.15	—	—	13	56.62
Total	196	57.09	298	57.02	298	57.12	100	56.79	98	56.90	96	56.55	100	56.86

Area	Fladen Ground										North Minch		Firth of Forth		Long Forties	
Month	VI		VII		VIII		IX		X		VIII		VI		VI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	4	57.50	1	58.00	3	57.00	35	56.63	12	56.58	4	56.75	149	56.67	12	56.75
II	26	57.04	26	56.86	15	56.40	38	56.45	8	56.38	4	57.00	38	56.82	72	56.67
III	58	56.33	119	56.58	16	56.69	87	56.97	4	57.00	5	56.60	4	56.25	67	56.60
IV	11	56.57	135	56.50	190	56.41	63	56.83	13	56.92	33	56.46	2	56.00	7	56.86
V	—	—	95	56.45	56	56.52	3	56.66	10	56.70	41	56.59	—	—	1	57.00
VI	—	—	—	—	—	—	—	—	16	56.56	—	—	2	56.50	1	57.00
VII	—	—	—	—	—	—	—	—	3	56.33	—	—	—	—	13	56.77
VII/II	—	—	1	58.00	14	56.57	63	56.68	33	56.00	11	56.18	—	—	24	56.83
Total	99	56.57	377	56.54	294	56.47	289	56.76	99	56.43	98	56.52	195	56.68	197	56.69

Area	Gut		Dogger Bank				SW of Egersund				Skagerak		Sandettié	
Month	X		IX		X		XI		XII		XII		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	504	56.58	104	56.46	1015	56.57	23	56.61	16	56.63	187	56.52	—	—
II	26	56.35	5	55.40	108	56.44	25	56.44	53	56.51	7	56.57	—	—
III	2	57.00	40	56.58	15	56.80	—	—	22	57.00	—	—	—	—
IV	7	56.43	50	56.66	49	56.71	4	57.25	37	57.24	1	57.00	—	—
V	4	56.75	60	56.52	45	56.58	3	57.33	13	57.08	—	—	29	56.55
VI	4	57.00	39	56.51	252	56.53	—	—	—	—	—	—	262	56.56
VII	26	56.31	—	—	187	56.57	2	56.50	10	56.50	—	—	3	56.00
VII/II	111	56.55	—	—	133	56.48	39	56.49	29	56.48	2	56.50	—	—
Total	684	56.56	298	56.51	1804	56.56	96	56.56	180	56.77	197	56.52	294	56.55

Area	East of Dogger						German Bight					
Month	VIII		IX		X		III		VI		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver	No.	Aver.	No.	Aver.	No.	Aver.
I	184	56.48	99	56.44	469	56.44	12	56.58	195	56.57	94	56.51
II	4	56.00	—	—	—	—	32	56.22	—	—	—	—
III	7	56.57	—	—	—	—	—	—	—	—	—	—
IV	2	57.00	—	—	6	56.60	—	—	—	—	—	—
V	—	—	—	—	—	—	1	56.00	—	—	—	—
VI	—	—	—	—	—	—	—	—	—	—	—	—
VII	—	—	—	—	—	—	1	57.00	—	—	—	—
VII/II	—	—	—	—	2	56.00	49	56.53	—	—	—	—
Total	197	56.48	99	56.44	477	56.44	95	56.43	195	56.57	94	56.51

Table 20 (continued)

Area	South Ireland				North Ireland (Klondyke)					
Month	I		II		III		VI		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	1	57.00	—	—	—	—	—	—
II	—	—	10	56.90	4	56.50	70	56.79	12	56.83
III	—	—	—	—	—	—	—	—	5	56.60
IV	—	—	—	—	—	—	—	—	33	56.87
V	8	57.13	1	56.00	—	—	—	—	13	57.08
VI	281	56.98	—	—	2	56.50	—	—	—	—
VII	8	56.75	25	56.96	79	56.73	—	—	—	—
VII/II	1	58.00	63	56.89	11	57.09	29	56.90	37	56.46
Total	298	56.98	100	56.90	96	56.76	99	56.82	100	56.73

Table 21. Keeled scales (K_2) in relation to stages of maturity

Area	Viking Bank/Utsira								Bressay Shoal					
Month	II		III		IV		V		V		VI		VIII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	1	15.00	4	14.00	—	—	—	—	—	—	—	—
II	1	14.00	—	—	38	13.89	61	14.11	74	14.19	14	14.93	18	14.00
III	—	—	—	—	2	14.50	—	—	—	—	72	14.71	28	13.82
IV	10	13.80	—	—	2	14.00	—	—	—	—	11	14.91	32	14.47
V	167	13.92	249	13.84	5	14.40	—	—	—	—	—	—	5	15.40
VI	16	14.00	22	13.86	6	13.83	—	—	—	—	—	—	—	—
VII	—	—	19	14.21	68	13.90	4	14.75	—	—	—	—	—	—
VII/II	—	—	1	15.00	160	13.94	10	14.60	18	14.00	—	—	13	14.54
Total	194	13.92	292	13.87	285	13.93	75	14.21	92	14.15	97	14.76	96	14.44

Area	Fladen Ground										North Minch		Firth of Forth		Long Forties	
Month	VI		VII		VIII		IX		X		VIII		VI		VI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	4	14.25	1	15.00	3	13.67	29	14.14	11	14.09	4	14.25	148	14.64	7	14.71
II	26	14.00	24	14.29	14	14.50	37	14.30	8	13.96	4	14.00	38	14.71	57	14.53
III	55	14.98	117	14.62	16	14.19	85	14.31	4	15.50	5	14.20	4	14.50	64	14.31
IV	12	15.00	129	14.71	184	14.61	61	14.70	13	15.23	33	14.12	2	14.00	7	14.14
V	—	—	90	14.57	57	14.72	3	14.00	10	15.10	41	14.32	—	—	1	14.00
VI	—	—	—	—	—	—	—	—	17	14.76	—	—	2	14.50	1	15.00
VII	—	—	—	—	—	—	—	—	3	15.33	—	—	—	—	12	14.58
VII/II	—	—	1	16.00	13	14.85	63	14.59	33	14.91	10	14.20	—	—	20	14.70
Total	97	14.69	362	14.63	287	14.47	278	14.44	99	15.07	97	14.22	194	14.64	169	14.46

Area	Gut		Dogger Bank				SW of Egersund				Skagerak		Sandettié	
Month	X		IX		X		XI		XII		XII		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	436	14.12	97	14.20	1000	14.28	25	14.28	16	13.88	184	14.26	—	—
II	22	14.77	5	14.40	105	14.99	26	14.35	54	14.61	7	14.57	—	—
III	1	15.00	39	14.67	15	14.87	—	—	23	13.61	—	—	—	—
IV	5	15.00	52	15.04	49	14.92	4	13.75	36	13.89	1	15.00	—	—
V	4	15.25	57	14.74	47	15.02	4	13.75	12	14.00	—	—	29	14.90
VI	3	15.33	38	14.68	342	14.95	—	—	—	—	—	—	256	14.98
VII	23	14.65	—	—	99	15.08	2	14.00	10	14.80	—	—	3	14.37
VII/II	90	14.84	—	—	133	14.84	39	14.59	29	14.62	2	15.50	—	—
Total	584	14.30	288	14.59	1790	14.58	100	14.37	180	14.24	194	14.28	288	14.96

Table 21 (continued)

Area	East of Dogger						German Bight					
Month	VIII		IX		X		III		VI		XII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	158	14.24	86	14.38	412	14.46	13	15.31	74	14.32	92	14.91
II	6	13.83	—	—	—	—	32	15.00	—	—	—	—
III	6	14.83	—	—	1	15.00	—	—	—	—	—	—
IV	3	14.67	—	—	3	16.00	—	—	—	—	—	—
V	—	—	—	—	—	—	1	15.00	—	—	—	—
VI	—	—	—	—	—	—	—	—	—	—	—	—
VII	—	—	—	—	—	—	1	14.00	—	—	—	—
VII/II	—	—	—	—	1	15.00	52	14.79	—	—	—	—
Total	173	14.25	86	14.38	417	14.48	99	14.92	74	14.32	92	14.91

Area	South Ireland				North Ireland (Klondyke)					
Month	I		II		III		VI		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	1	14.00	—	—	—	—	—	—
II	—	—	10	14.40	4	14.00	71	14.49	12	14.33
III	—	—	—	—	—	—	—	—	4	13.50
IV	—	—	—	—	—	—	—	—	33	14.12
V	8	14.63	1	14.00	—	—	—	—	13	14.00
VI	279	14.62	—	—	1	15.00	—	—	—	—
VII	8	14.63	24	14.75	78	14.42	—	—	—	—
VII/II	1	15.00	63	14.62	11	14.55	29	14.50	37	14.35
Total	296	14.62	99	14.62	94	14.43	100	14.49	99	14.19

8. SW of Egersund, Skagerak

Five samples containing 1,860 fish were investigated. Three in November and December came from SW of Egersund area, 2 in December from the Skagerak. The average length in the Egersund area was 27.73 and 30.11 cm respectively, in the Skagerak 23.06 cm (Table 16). Stages VII/II (392‰), I and II (508‰) were predominant in November in the Egersund area, while stages II (295‰), III/IV (328‰), and VII/II were abundant. In the Skagerak in December only stage I (950‰) was predominant (Table 17). In November the 4 (300‰), 2 (240‰), and 6 (130‰) year-old fish formed the bulk of the catch, while in December the 9 and 10 year-old and older herring had some importance. However, in the Skagerak only the 2 year-old fish (945‰) were predominant (Table 18). The average number of vertebrae were in the Egersund area 56.56 and 56.78, and in the Skagerak 56.52 (Table 19). Stage I in both areas were autumn spawners from the north-western Dogger Bank area, while stage II belonged to the Bank herring group. Stages III—V were late winter spawners while stages VII and VII/II were again Bank herring (Tables 20—22).

9. Young herring east of Dogger Bank

From July to October 8 samples with 7,169 fish were investigated. The average length in the different months were 18.72, 19.10, 19.95, and 17.31 cm (Table 16). In September all herring were immature, while in August and October a small number of adult fish were present in the catches (Table 17). The bulk of the catches were 2 year-old fish (670—1000‰), in August and October some 3 and 4 year-old fish were present and moreover in October 1 year-old herring appeared (301‰) (Table 18). The average number of vertebrae of the immature herring were 56.44—56.48 (Table 19). It seems that the stock was presumably a mixture of the different autumn spawning stocks, of which the group of Bank herring was predominant (Tables 20—22).

10. German Bight

Five samples with 509 herring were investigated from the German Bight in March, June, and December. The average lengths in the different months were 23.86, 14.12, and 12.02 cm (Table 16). In March fish at different maturity stages were caught. Predominant were stages VII/II (530‰), II (320‰), and I (130‰). In June and December the catches consisted of immature herring (Table 17). Predominant in March were the 3 (577‰), 2 (181‰), and 4 year-old fish, while in June and December only 1 year-old fish were present (Table 18). The average numbers of vertebrae were 56.43, 56.57, and 56.51 (Table 19). In March, fish at maturity stages VII/II and II were Bank herring while stage I fish seem to be a mixture of the two groups of autumn herring. In June the immature herring were a mixture, while in December Bank herring were predominant (Tables 20—22).

Table 22. Gill rakers in relation to stages of maturity

Area	Viking Bank/Utsira								Bressay Shoal					
Month	II		III		IV		V		V		VI		VIII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	1	49.00	4	49.25	—	—	—	—	—	—	—	—
II	1	47.00	—	—	41	48.27	80	47.09	79	47.67	10	46.60	18	48.06
III	—	—	—	—	2	48.50	—	—	—	—	59	46.78	29	48.49
IV	10	49.00	—	—	1	48.00	—	—	—	—	8	46.50	33	46.64
V	173	48.72	254	48.54	6	48.67	—	—	—	—	—	—	6	45.50
VI	16	49.19	23	49.00	8	48.63	—	—	—	—	—	—	—	—
VII	—	—	19	48.53	71	48.44	5	48.08	—	—	—	—	—	—
VII/II	—	—	1	47.00	166	48.06	13	47.92	20	48.75	—	—	11	46.18
Total	200	48.76	298	48.57	299	48.52	98	47.29	99	47.89	77	46.73	97	47.34

Area	Fladen Ground										North Minch		Firth of Forth		Long Forties	
Month	VI		VII		VIII		IX		X		VIII		VI		VI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	4	47.00	1	47.00	3	49.00	35	47.43	12	47.83	4	48.25	153	45.93	12	46.00
II	26	48.54	26	47.58	15	47.06	38	47.82	8	46.00	4	48.75	40	46.08	72	46.47
III	58	46.14	119	46.50	15	46.66	89	47.49	4	45.25	5	46.60	4	47.75	67	46.46
IV	10	46.20	135	46.56	188	46.76	62	46.55	13	46.00	33	46.73	2	45.50	6	47.17
V	—	—	96	46.31	58	46.24	32	46.69	10	45.50	41	46.76	—	—	1	50.00
VI	—	—	—	—	—	—	—	—	17	46.24	—	—	2	45.50	1	48.00
VII	—	—	—	—	—	—	—	—	3	48.33	—	—	—	—	12	46.50
VII/II	—	—	1	48.00	12	46.75	35	46.43	33	46.12	11	46.64	—	—	24	45.92
Total	98	46.82	378	46.55	291	46.41	291	47.11	100	46.29	98	46.87	201	45.99	195	46.42

Area	Gut		Dogger Bank				SW of Egersund				Skagerak		Sandettié	
Month	X		IX		X		XI		XII		XII		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	397	47.00	99	47.19	1021	46.71	26	47.00	16	47.63	189	47.15	—	—
II	22	46.09	5	46.40	137	45.75	26	46.77	54	46.43	7	46.71	—	—
III	—	—	40	45.98	15	45.06	—	—	22	48.45	—	—	—	—
IV	2	44.00	50	45.80	48	45.25	5	48.20	37	48.22	2	45.50	—	—
V	4	47.25	59	45.88	48	45.54	4	48.00	13	48.46	—	—	29	45.52
VI	2	47.00	40	46.13	360	45.93	—	—	—	—	—	—	268	45.52
VII	22	45.55	—	—	129	46.10	2	44.50	10	45.50	—	—	3	45.33
VII/II	50	46.24	—	—	125	45.94	40	46.00	30	46.50	2	46.00	—	—
Total	499	46.81	293	46.37	1883	46.32	103	46.60	182	47.25	200	47.11	300	45.51

Area	East of Dogger		German Bight		South Ireland				North Ireland (Klondyke)					
Month	X		III		I		II		III		VI		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	473	45.34	13	45.31	—	—	1	48.00	—	—	—	—	—	—
II	—	—	32	45.75	—	—	10	46.50	4	48.25	71	47.31	12	47.00
III	1	47.00	—	—	—	—	—	—	—	—	—	—	5	48.00
IV	7	46.00	—	—	—	—	—	—	—	—	—	—	33	47.91
V	—	—	1	45.00	8	47.75	1	49.00	—	—	—	—	13	48.85
VI	—		—	—	283	46.93	—	—	2	47.00	—	—	—	—
VII	—	—	1	43.00	8	46.88	25	47.16	83	47.51	—	—	—	—
VII/II	2	45.00	53	45.74	1	48.00	63	46.97	11	47.91	29	47.90	37	47.05
Total	483	45.35	100	45.65	300	46.95	100	47.00	100	47.57	100	47.49	100	47.61

Table 22 A. The different herring stocks according to German investigations (maturity stages V–VII)

	Vertebrae	Keeled scales	Gill rakers
Atlanto-Scandian herring			
Viking/Utsira	57.00–57.13	13.84–13.94	48.54–49.19
Bank herring			
Fladen/Gut/Dogger Bank	56.41–56.53	14.57–14.95	45.93–46.31
N. Minch autumn herring			
Cape Wrath	56.46–56.59	14.12–14.32	46.73–46.76
Downs herring			
Sandietté	56.56	14.90–14.98	45.52
South Ireland herring			
Dunmore	56.89–56.98	14.62–14.75	46.93–47.16
North Ireland herring			
Klondyke	56.73–57.09	14.42–14.55	47.51–47.91

11. South Ireland

In January and February 4 samples comprising 1,610 fish from the Dunmore area were investigated. The average length was 28.38 and 27.30 cm (Table 16). In January spawning herring (950‰) was predominant, while in February spent (250‰) and recovering spent (630‰) herring were abundant (Table 17). The 4 (346‰), 5 (212‰), and 7 year-old fish (193‰) were in January predominant, while in February the 7 (290‰), 5 (258‰), and 9 year-old herring formed the bulk of the catches (Table 18). The average number of vertebrae were 56.98 and 56.90. The average number of vertebrae for the maturity stages VI—VII/II were 56.89 to 56.98, the keeled scales 14.62—14.75 and the gill rakers 46.93—47.16 (Tables 20—22).

12. North Ireland (Klondyke)

Three samples in March, June, and November with 998 herring were investigated. The average length was 26.23, 30.21, and 30.29 cm (Table 16). In March maturity stages VII (830‰) and VII/II (110‰) were abundant, in June stages II (710‰) and VII/II (290‰) were predominant, while in November a mixture of herring at different maturity stages were present in this area. Predominant were the stages VII/II (490‰), IV and V (460‰) (Table 17). In March the bulk of the catches was formed by the 6 (275‰), 7 (200‰), 4 (175‰), and older than 10 year-old herring. In June the 6 (194‰), 7 (174‰), 4 (153‰), 5 (153‰), and 10 year-old fish were predominating. In November the 5 (244‰), 6 (211‰), 7 (178‰), 4 (134‰), and 8 year-old herring were abundant (Table 18). The average number of vertebrae were 56.76, 56.82, 56.73 (Table 19). The bulk of the catches in March were formed by late winter spawners, presumably the older fish were of the Clyde stock. The average number of vertebrae for the maturity stages VI—VII/II were 56.73—57.09, the keeled scales 14.42—14.55 and the gill rakers 47.51 to 47.91. In June the fishing was carried out on the same stock. However, in November there was a mixture of different stocks in this area. Stages VII/II and II were autumn spawners perhaps from the Minch area, while the other stages were perhaps a mixture of the late winter spawners from the North Ireland and Atlanto-Scandian groups.

Summary

The German fishing fleet fished on different herring stocks in 1958. The discrimination of single individuals of these stocks is at present impossible. Only the distinction between single late winter and autumn spawners is to some extent possible. The autumn spawners are distinguished by the averages of different meristic characters in relation to stages of maturity. Table 22 A shows these averages for both groups according to the investigations of 1958.

The catch of the German fishing fleet showed in 1958 a decline by about 18.9%. This was mainly due to the smaller catches of the trawlers and trawl-luggers in the summer season. The Bank herring which are present at this time in the Fladen Ground area, Gut, and Dogger Bank area and which form the bulk of the German catches, were absent on the bottom in July and the beginning of August. Hydrographical investigations by the German fishery patrol vessel showed that in May/June the Fladen Ground, Gut, and Dogger Bank area had bottom temperatures below 5.8°C. Also in July the Fladen Ground and the Gut showed the same temperature. In August this cold bottom water was encountered, as in previous years, only in the central area of the Fladen Ground. A second core of cold bottom water existed as usual extending from the Gut to the Great Fisher Bank. Our investigations in recent years have shown that concentrations of herring to a certain extent can be correlated to a temperature of 5.8°C. At tempera-

tures below 5.5°C no herring were found. However, the result of the drift-net fishery in this area was good. We may suppose that the failure of the trawlers last year was partially conditioned by the hydrographical situation, as the herring at that time was staying over the bottom.

The age composition in the Fladen Ground area showed that only 3 year-classes were important for the stock (1954, 1952, 1953). Besides, the 1953 year-class (5 year-old herring) seems to be weak. The 1955 year-class (3 year-old) was poor on the Fladen Ground and had only some importance in the Dogger area. It seems therefore that the density of the stock was not so great as in former years a factor also influencing the yield. In the Gut and Dogger area large shoals of 2 year-old herring (1956 year-class) were present which, according to their meristic characters did not belong to the Bank group. They showed a fast growth and seemed to be derived from spawning places with more oceanic influx. The averages of the meristic characters showed some similarity to those of the North Minch autumn stock. They were economically not attractive for the fishery.

K. Schubert

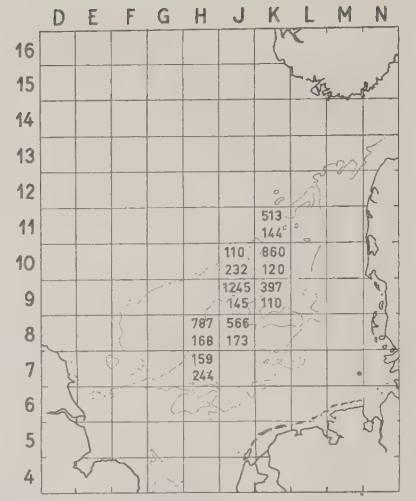
Young Herring from the Bløden Ground Area

(Figure 15; Charts 1–10)

Market sampling and market measurements were carried out as usual by aid of the fishery control officers in Esbjerg. Research trawling was carried out from R/V "Jens Væver" in connexion with the ICES pre-tagging survey in July/August.

Spring season (January/May)

In contrast to the same season in 1957 the fishery was clearly concentrated on the grounds east and south-east of the Dogger Bank. As expected the 1956 year-class (I-group) was strong and made up about 88% of the total number of fish landed. Year-class 1955 and older fish only accounted for about 12%. Charts 1—4 show the distribution and yield of the fishery from Esbjerg. The upper figure shows the total catch in metric tons, the lower figure the catch in tons per 100 hours of pair trawling. As information only is available for a part of the landings, reported landings have been raised to the totals by conversion factors calculated for each week. Catch and effort for single trawlers have been incorporated in the charts by



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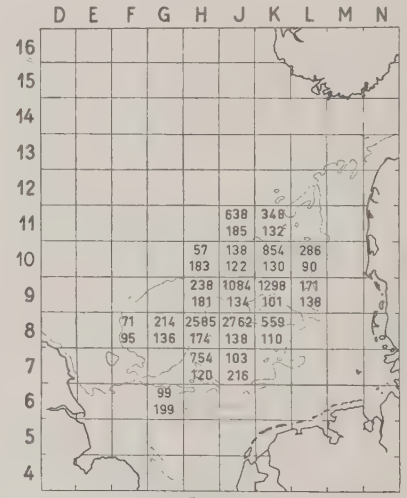
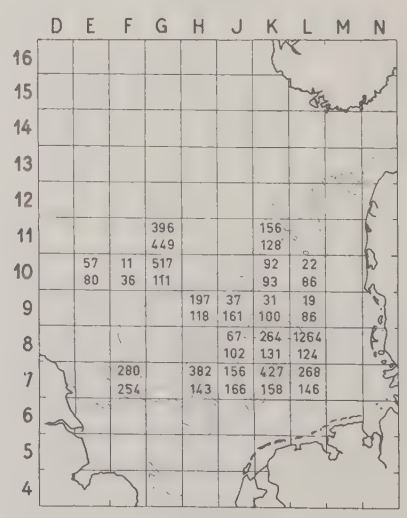


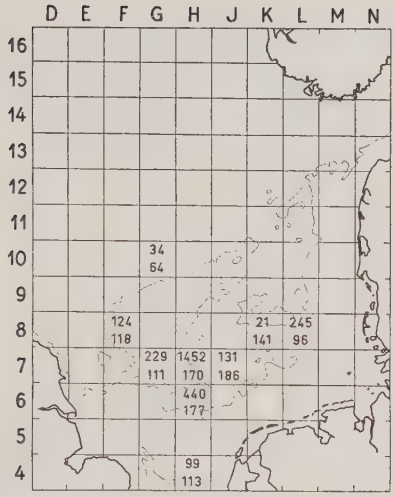
March



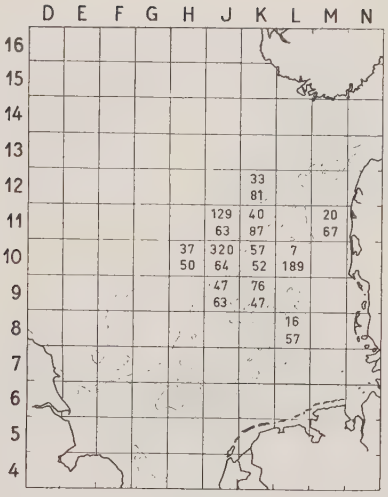
April

Charts 1—10: Danish herring trawl fishery. Esbjerg 1958. In squares: upper figure = total catch in metric tons. Lower figure = Average catch in tons per 100 hours paired trawling.

Charts 1–3.



Charts 4–5. May



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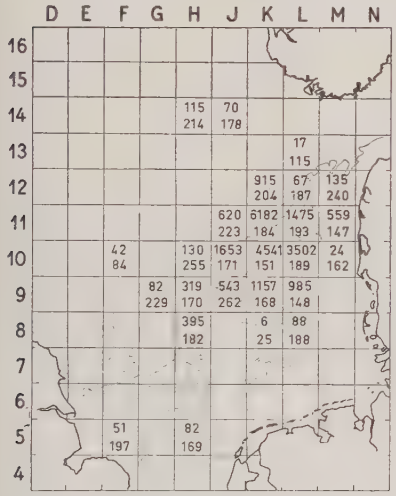
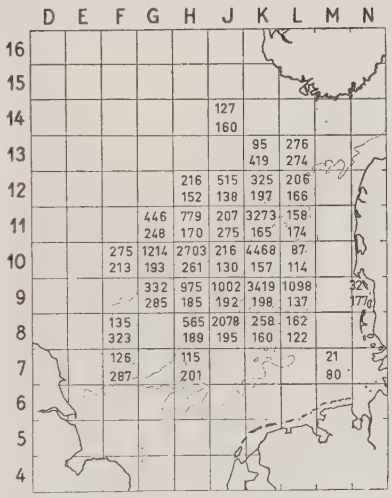
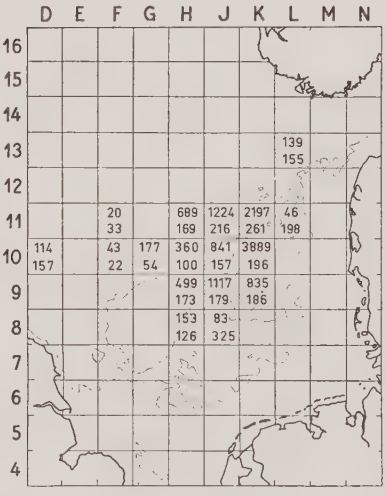


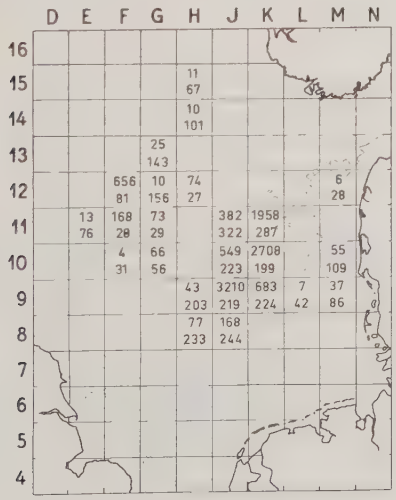
Charts 6–8. August



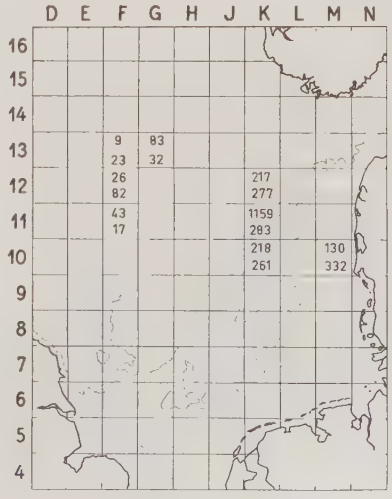
September



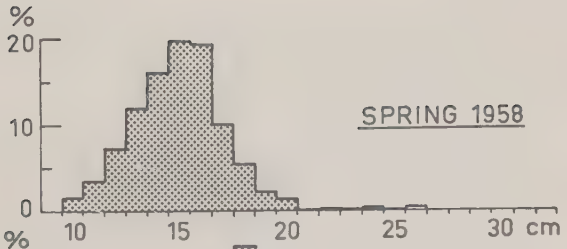
October



Charts 9–10. November



December



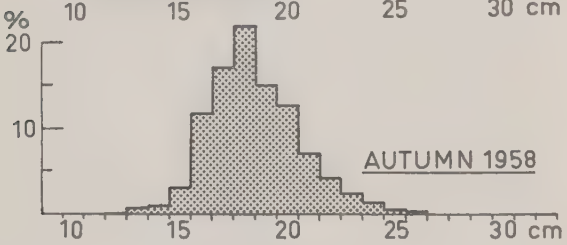


Figure 15a. Total length distribution. Bløden fishery. Spring 1958.

Figure 15b. Total length distribution. Bløden fishery. Autumn 1958.

raising the effort of single trawlers to that of pair trawlers in accordance with their relative fishing power.

The total length distribution is shown in Figure 15 a.

Autumn season (July/December)

The fishery started in strength rather late as compared with earlier years, but the very good occurrences of herring provided a good fishery and the season closed with a total catch of about 75,000 tons landed in Esbjerg (against 48,000 tons in 1957). Charts 5—10 show the distribution of the fishery. A feature of interest is the formation, already in August, of a quite good concentration of young herring north of Dogger. This concentration disappeared during early October and from the more detailed weekly charts, upon which the monthly charts published here are based, it may be deduced, that the North Dogger patch moved northwards in direction of the Gut.

Figure 15 b shows the total length distribution of the autumn season. The length of the herring was smaller than in any Bløden season since the fishery started, and this in connexion with what may be the reappearance of Bjerkan's NW-Dogger patch (Bjerkan, 1918) may indicate a return to the pre-war pattern of recruitment (Cushing, 1959).

0-group (1957 year-class) only made up about 4% of the total number of herring landed in Esbjerg. Year-class 1956 accounted for 92%, while older fish contributed with 4%. Year-class 1957 appears to be weak and it is reasonable to expect a considerable decrease in catch in 1959. As the fish of the 1956 year-class are small of size, however, it may also be expected that II-group herring will be abundant during the early part of the spring season 1959 and to some degree counteract the expected absence of I-group herring.

Meristic characters

Average numbers of keeled scales and vertebrae in the dominant 1956 year-class is shown below (numbers in brackets):—

	K_2		V. S.	
Spring	14.18	(445)	56.52	(1,213)
Autumn....	14.35	(801)	56.48	(2,630)

The average numbers of K_2 are the lowest values hitherto observed. In the main there has been a steady decrease in K_2 since year-class 1949, but with our present knowledge concerning the factors governing this character an interpretation of the rather spectacular change is not possible.

K. Popp Madsen

The German Oil Herring Fishery in 1958

(Table 23)

In 1958, the oil herring fishing started as early as May and terminated in November. The total catch of all 869 fishing trips amounted to 25,894 metric tons, whereas in 1957 only 17,030 tons were caught in 876 fishing trips. The seasonal distribution of the total catch in 1958 and 1957 are as follows:—

Month	1958 (%)	1957 (%)
May	0.3	—
June	0.1	—
July	3.7	27.2
August	31.0	47.1
September ...	48.1	17.6
October	15.8	8.1
November ...	1.0	—

The average yield of each fishing trip amounted to 29.8 tons in 1958, and to 19.4 tons in 1957.

The oil herring catches were landed in the following fishing ports:—

	Tons
Cuxhaven	15,456
Bremerhaven	9,025
Hamburg-Altona	756
Büsum	657
Total	25,894

In 1958, more North Sea cutters participated in the oil herring fishing than in 1957, due to the low yields of the tuna fishery, wherein they are usually engaged. In 1957, only one oil herring fishing trip was accomplished by a North Sea

Table 23. Size composition of oil herring caught by German cutters

Sample Nos.	1	2	3	4	5	6
Date 1958	15. 8.	22. 8.	9. 9.	11. 9.	16. 9.	20. 9.
Cm						
13.0	—	—	—	—	—	2
13.5	—	—	—	—		2
14.0	—	—	—	—		1
14.5	—	—	—	—	—	—
15.0	—	1	—	—		—
15.5	—	2	—	—	—	—
16.0	—	15	—	—	—	6
16.5	3	41	—	1	5	10
17.0	2	41	2	2	17	64
17.5	11	46	9	3	21	53
18.0	21	22	18	6	26	55
18.5	21	20	29	14	26	36
19.0	17	9	38	28	19	13
19.5	13	10	37	30	8	3
20.0	12	13	18	14	12	2
20.5	10	3	14	15	12	1
21.0	7	6	19	13	10	—
21.5	9	6	10	6	9	—
22.0	5	—	7	14	4	1
22.5	4	3	5	3	4	—
23.0	1	1	2	2	3	—
23.5	1	—	—	2	1	—
24.0	—	—	—	2	—	—
24.5	—	—	—	2	—	—
25.0	1	—	1	—	—	
25.5	—	—	—	2	—	—

Locality of samples: 1 = Tail End; 2 = Northern Upper Scruff; 3 = South-Western Middle Reef; 4 = Western Middle Reef; 5 = Eastern Dogger; 6 = Upper Scruff.

cutter, whereas in 1958, 54 trips were made during September and 49 trips during October.

The fishing grounds were Tail End, Upper Scruff, Middle Reef, Eastern Dogger, and later around the shipping way between P_1 and P_6.

Six samples of abut 1,000 herring were measured during August and September. Their average length was 18.6 cm in August and 19.2 cm in September (see Table 23).

The by-catch was mainly composed of horse mackerel, large haddock and whiting, cod, mackerel, gurnard, and dab. It appeared that the very rich 1955 year-class of haddock and whiting, was still dominating.

P. F. Meyer-Waarden

I-Group, Scotland 1957—58

(Tables 24–25)

The landings and crude effort statistics for the "halflin" fisheries in the Firth of Forth and the upper Moray Firth are given in Table 24. The total landings in the Firth of Forth ring-net fishery were much greater than in the three previous years but the catch per unit effort was much the same. In the upper Moray Firth drift-net fishery both the total landings and the average catch fell considerably. An interesting feature of the Moray Firth fishery during January and February 1958 was that the fishermen had to use buoy-ropes 10—15 fathoms long instead of the usual 1—2 fathoms long because the herring were not rising.

The size-range, mean lengths and mean Vert.S. of the samples of "halflins" from the commercial fisheries and from trawl hauls by research vessels are given in Table 25. The vertebral counts show that spring spawners did not contribute much to the catches in the Firth of Forth or in the Moray Firth.

It is interesting that, whereas in the years 1949—1957 herring with 1 winter-ring constituted between 87 and 99% of the stock sampled in the upper Moray Firth with 2-ringed fish occurring in only very small proportions, in the 1957/58 season 2-ringed fish constituted as much as 32% of the sampled catch.

Table 24. Statistics of "halflin" fisheries 1953–58

	Season 1953–54	1954–55	1955–56	1956–57	1957–58
Upper Moray Firth					
Duration of season	12/9/53–20/3/54	18/9/54–26/3/55	1/10/55–31/3/56	6/10/56–9/2/57	14/9/57–22/2/58
Number of landings	2,654	1,715	2,989	2,274	891
Total catch (crans)	61,773	25,263	61,945	34,605	5,715
Catch/landing (crans)	23.3	14.7	20.7	15.2	6.4
Upper Firth of Forth					
Duration of season	26/12/53–10/4/54	18/10/54–23/3/55	24/9/55–31/3/56	8/9/56–16/3/57	21/9/57–19/4/58
Greatest number of boats engaged	29	22	16	16	22
Estimated catch of "halflins" (crans)	13,554	786	379	328	3,352
Estimated catch of "halflins" per arrival (crans)	6.01	5.46	12.53	6.31	7.56

Table 25. Length and mean Vert. S. of I- and II-group herring in the inshore waters off the Scottish east coast in 1957–58

(Numbers in brackets)

Locality	Date	Range (cm)	Mean length (cm)		Mean Vert. S.	
Autumn 1955 and spring 1956 broods						
Firth of Forth	Oct. 1957[1])	16–21	18.81	(86)	56.40	(84)
	Jan. 1958[1])	16–23	19.70	(88)	56.56	(85)
	Feb. 1958[1])	18–23	20.20	(93)	56.49	(89)
	Mar. 1958[1])	18–24	21.09	(35)	56.60	(35)
Upper Moray Firth	Sept. 1957[2])	18–23	20.33	(27)	56.63	(27)
	Oct. 1957[2])	18–22	20.11	(89)	56.54	(89)
	Nov. 1957[2])	19–22	20.06	(47)	56.36	(45)
	Dec. 1957[3])	18–23	20.72	(177)	56.46	(175)
	Jan. 1958[2])	18–24	20.88	(131)	56.46	(127)
	Feb. 1958[2])	20–23	20.94	(36)	56.53	(36)
Autumn 1954 and spring 1955 broods						
Upper Moray Firth	Sept. 1957[2])	20–25	22.92	(73)	56.56	(73)
	Oct. 1957[2])	20–24	22.18	(57)	56.47	(53)
	Nov. 1957[2])	21–23	21.67	(3)	55.67	(3)
	Dec. 1957[3])	20–26	23.11	(70)	56.51	(65)
	Jan. 1958[2])	22–25	23.35	(17)	56.35	(17)
	Feb. 1958[2])	22–25	23.14	(14)	56.86	(14)

[1]) Samples caught by ring-net.

[2]) Samples caught by drift-net.

[3]) Samples caught by trawl.

GEORGE MCPHERSON

Scottish Fisheries 1958

(Figures 16–19; Charts 11–22; Tables 26–41)

A. North Sea

Commercial Landings

Drift-net

During 1958 drift-net fishing was carried out from the following Scottish ports: Aberdeen (end of March to mid-September), Peterhead (May to August), Fraserburgh (May to mid-September), and Lerwick (May to early September). There were also a few landings at Wick during June and July.

The catch and effort statistics for the landings at these ports in 1958 and the previous three years are given in Table 26, and the detailed monthly statistics of catch and effort in each 10 mile square are given in Charts 11—22. Charts 11—16 give the number of hauls per month in each square and Charts 17—22 the corresponding average catch per 100 net haul for the same square.

The most striking feature of the fishery in 1958 was the poor fishing on the traditional Buchan grounds within a radius of 60 miles from the ports.

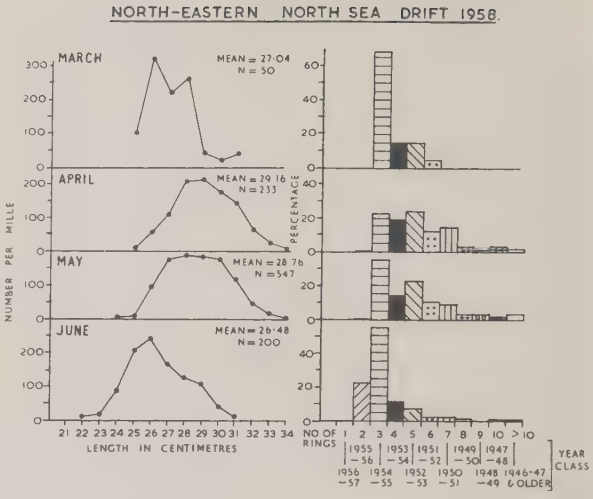


Figure 16. Length and age composition of north-eastern North Sea drift-net samples. March/June 1958. (Length frequencies unsmoothed).

During May most of the herring landed at Fraserburgh and Peterhead were caught in Shetland waters and during June and July the best catches came from the more distant grounds to the north and south of the Buchan area. The fishery on the spawning banks off the Scottish east coast in August/September was also relatively unproductive. In contrast, the fisheries on the more distant grounds to the east of the Shetlands and off Fair Isle from May to September and in the north-eastern North Sea in April and May were relatively productive.

Trawl

All the landings of trawled herring at Aberdeen in 1958 were made by Swedish vessels. There were sporadic landings from the north-eastern North Sea in February, April, and September—October, regular landings from the Fladen between July and October, and a few from the Gut also in September—October.

The catch and effort statistics for these fisheries for 1958 and the previous three years are given in Table 26. These suggest that the density of the stock fished in 1958 in the north-eastern North Sea and on the Fladen was less than in the previous three years. While the amount landed from the Gut region was much smaller than in previous years the catch per unit effort was approximately the same as in 1957 and 1958.

Age, Length and Racial Composition of Samples

Sampling of the drift-net landings at Aberdeen, Peterhead, Fraserburgh, and Lerwick in 1958 was conducted as in previous years.

Table 26. East coast and Shetland landings, 1955—1958

Drift-net

	Landings (crans)				Arrivals				Average landing per arrival[1] (crans)			
	1955	1956	1957	1958	1955	1956	1957	1958	1955	1956	1957	1958
Fraserburgh ..	171,462	84,831	75,704	54,835	5,740	3,811	4,226	2,552	29.9	22.3	17.9	21.5
Peterhead	89,454	54,337	50,014	21,955	2,984	1,720	2,334	1,064	30.0	31.6	21.4	20.6
Lerwick	43,216	42,019	39,380	40,092	1,753	1,966	1,483	1,718	24.9	21.4	26.6	23.3
Wick	2,614	2,325	44	239	74	57	11	29	35.3	40.8	4.0	8.2
Aberdeen	73,041	58,996	60,939	49,883	959	858	950	862	76.2	68.8	64.2	57.9

Trawl

	Landings (crans)				Hours fishing				Landing per 100 hours (crans)			
North-eastern North Sea ..	948	1,254	959	2,086	121	310	310	1,064	783.5	404.5	309.4	196.1
Fladen	1,268	2,721	906	4,709	311	1,269	400	2,694	407.7	214.4	226.5	174.8
Gut and southwards .	10,912	4,625	6,199	518	3,090	1,850	2,136	194	353.1	250.0	290.2	269.8

[1]) These figures are not adjusted to standard number of nets per haul. Each arrival at Aberdeen represents on average two hauls, each arrival at other drift-net ports usually only one haul.

Table 27. Maturity and racial characters — North-eastern North Sea, 1958

	A. Percentage Maturity (All age-groups) Maturity stage									B. Vert. S. (Actual numbers — all age-groups) Number of vertebrae							
	I	II	III	IV	V	VI	VII	VII-II	Number	54	55	56	57	58	59	Mean	Number
March	4.0	2.0	—	2.0	—	4.0	2.0	**86.0**	50	—	1	16	28	4	—	56.71	49
April	0.4	**22.7**	—	—	—	1.3	**18.9**	**56.7**	233	—	6	86	117	20	1	56.67	230
May	0.9	**25.6**	—	—	—	—	13.2	**60.3**	547	—	19	217	264	35	1	56.59	536
June	17.5	**44.0**	20.0	5.5	2.5	—	1.0	9.5	200	—	19	84	77	12	—	56.43	192

Table 28. Age composition of spring and autumn spawners in north-eastern North Sea between March and June 1958

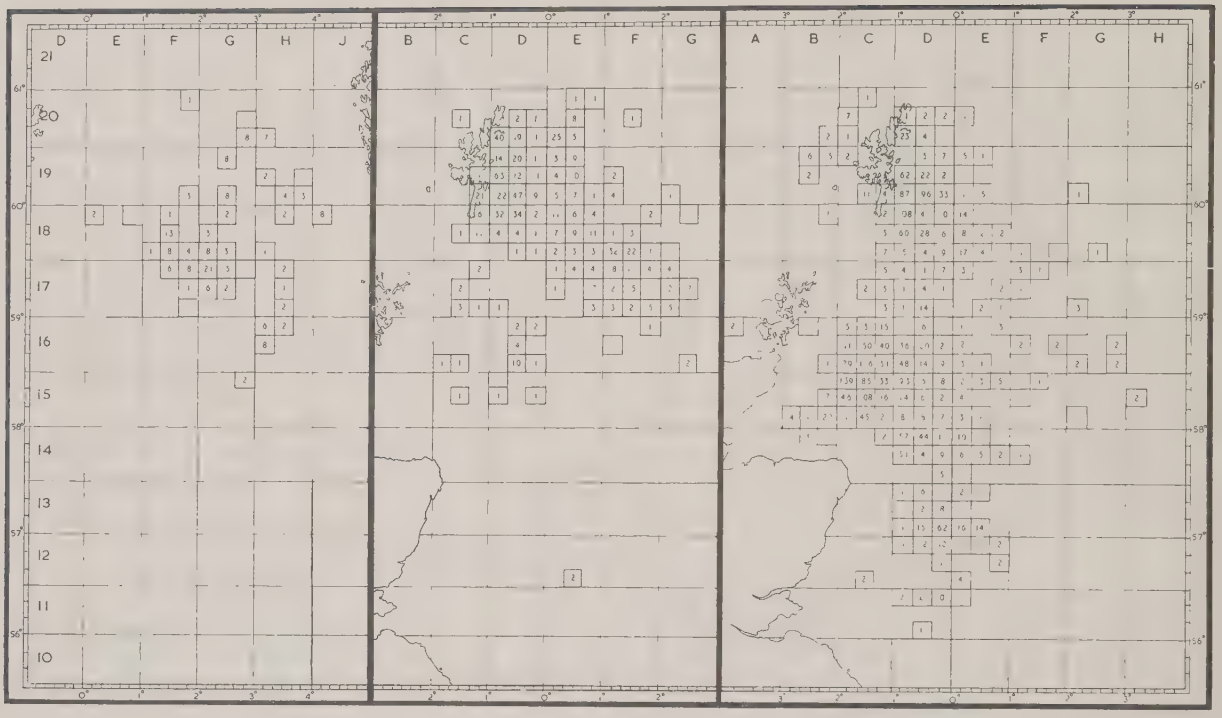
Spring group						Autumn group						Total sample			
Year-class	Winter-rings	March %	Apr. %	May %	June %	Year-class	Winter-rings	March %	Apr. %	May %	June %	Number Spring	Number Autumn	% Spring	% Autumn
1956	2	—	—	—	6.7	1955	2	—	0.6	0.2	23.4	1	45	2.2	97.8
1955	3	50.0	7.2	13.0	40.0	1954	3	69.6	28.8	41.0	56.5	28	359	7.2	92.8
1954	4	—	23.2	20.9	46.7	1953	4	15.2	17.2	11.7	8.2	47	100	32.0	68.0
1953	5	—	11.6	20.9	—	1952	5	15.2	28.2	22.4	7.1	32	162	16.5	83.5
1952	6	50.0	17.4	17.4	—	1951	6	—	9.2	8.4	2.2	34	55	38.2	61.8
1951	7	—	34.8	23.5	6.7	1950	7	—	4.9	4.7	1.1	52	30	63.4	36.6
1950	8	—	5.8	1.7	—	1949	8	—	1.8	3.7	0.5	6	20	23.1	76.9
1949	9	—	—	0.9	—	1948	9	—	1.8	3.5	—	1	18	5.3	94.7
1948	10	—	—	1.7	—	1947	10	—	4.9	1.2	0.5	2	14	1.3	87.5
1947 and older	>10	—	—	—	—	1946 and older	>10	—	2.5	3.3	0.5	—	19	—	100.0
Total number		4	69	115	15			46	163	429	184	203	822	19.8	80.2

North-eastern North Sea (grounds east of 1°E)

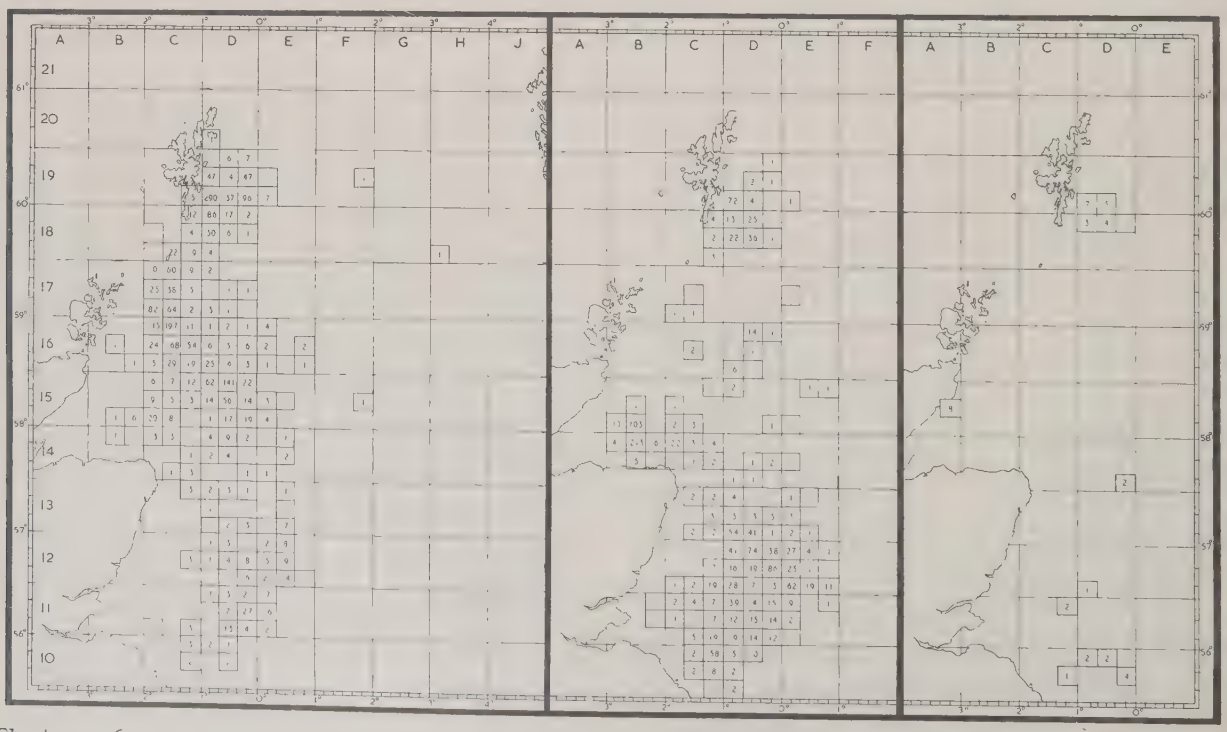
The length and age composition of the combined samples taken in the north-eastern North Sea between March and June are shown in Figure 16. The maturity and Vert. S. data are given in Table 27, and the age composition of the spring and autumn spawning components of the samples derived from the analysis of otolith racial characters is given in Table 28.

These data show that the stock fished in this area in 1958 was composed of recovering spent and maturing autumn spawners, which constituted 80% of the sampled catch, and spawning, spent, and recovering spent spring spawners. The spring

Number of Hauls

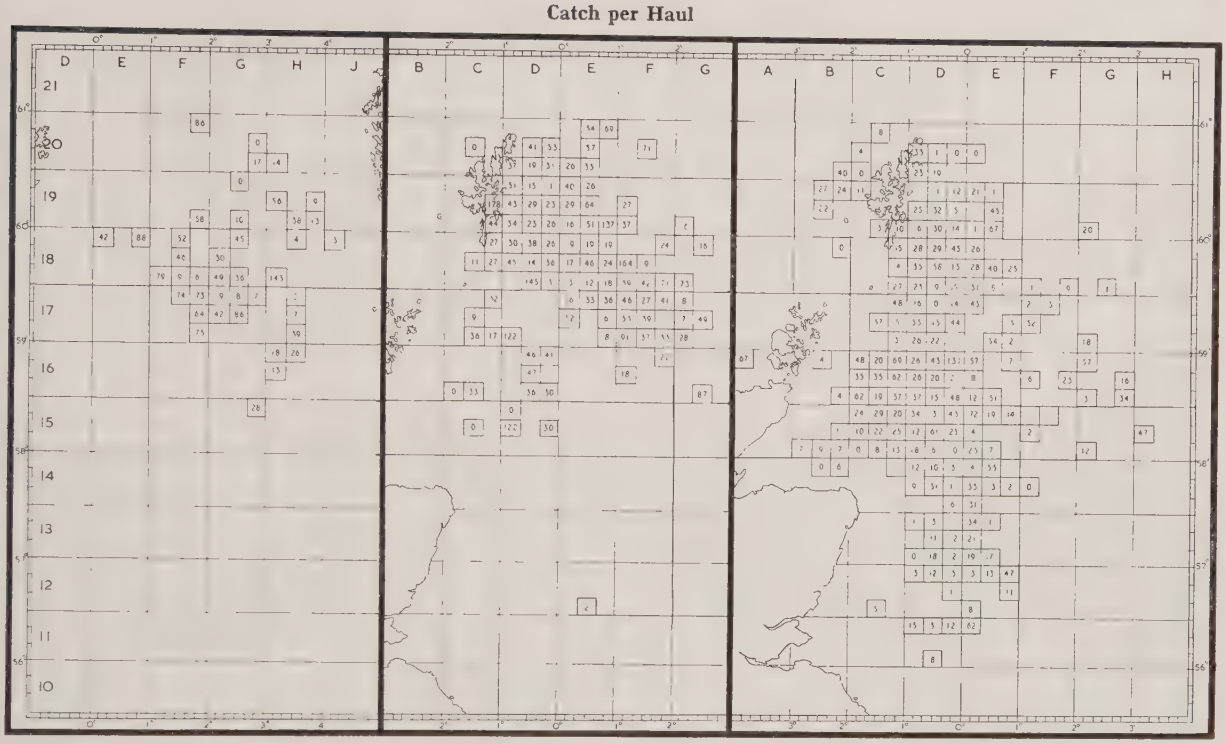


Charts 11–13. March/April May June

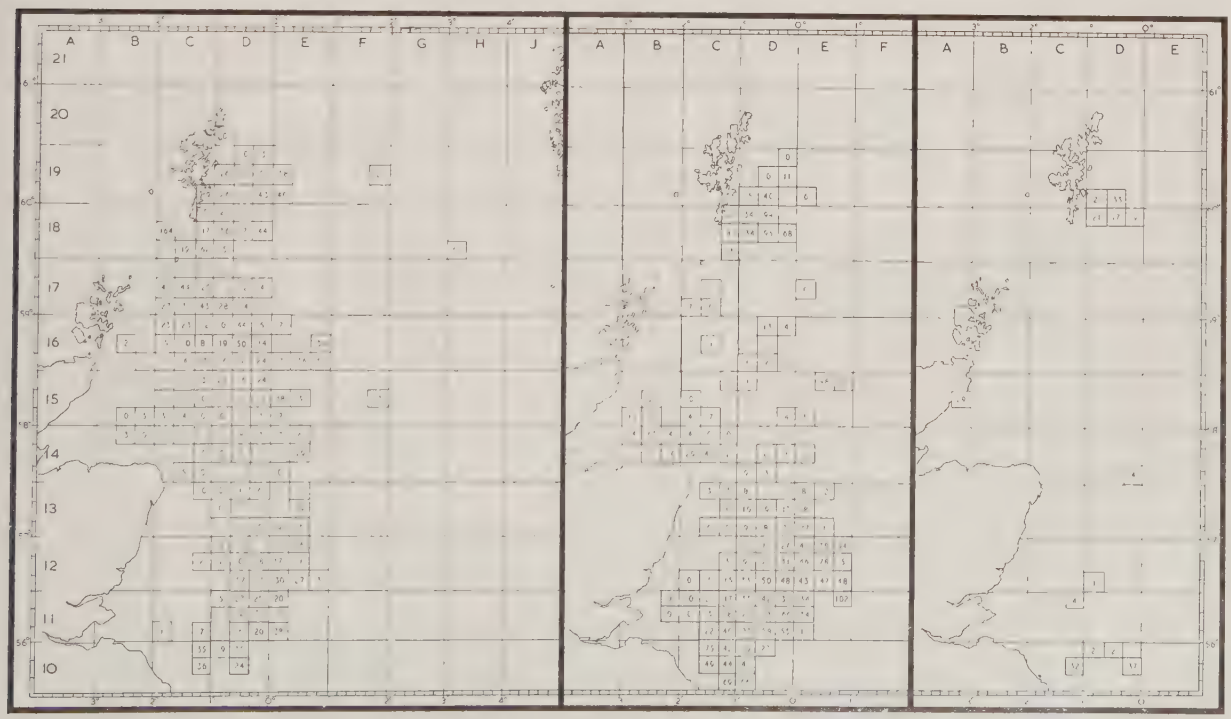


Charts 14–16. July August September

Catch per Haul



Charts 17–19. March/April May June



Charts 20–22. July August September

Table 28 A.

	Aberdeen			Fraserburgh			Peterhead			Lerwick		
May	19D	19E		20D	19C	19D				20D	19D	18D
	18D	18E					16C	16D				
June	19D	19E					17E			20D		
	18D	18E		16C			16C	16D		19D		
	17D	16C	16E	15C	15D		15C	15D		18D		
	15D	13E	11E		14D			14D	13D			
July	19D			17C			17C				19D	
	17C	16C	16E	16C	16D		16C	16D		18C	18D	
	15D	14E	13D		15D		15C	15D	14C			
	12E	11D	11E					13D	12D			
August	12C	12D	12E	16D	15B	14B	14B	14C			19D	
	11C	11D	11E	13D				13C	13D	18C	18D	
	10C			11D				12D	11D			
September		10D								19D	18D	

spawning component, principally members of the Atlanto-Scandian tribe consisting mainly of 3—7 winter-ringed fish, amongst which the 7-ringed fish were prominent, constituted a smaller proportion of the total sample than in recent years. The autumn spawning component was composed of a wider range of ages amongst which the 3-ringed 1954 year-class and the 5-ringed 1952 year-class predominated.

North-western North Sea (grounds west of 1°E)

The statistical squares sampled each month are shown in Table 28 A.

The length and age composition of the samples from the north-western North Sea are shown in Figure 17, and the maturity and Vert. S. data are given in Table 29.

For the first time since 1952 (Ann. Biol., Vols. IX—XIV) 2-ringed fish (3 year-olds) was not the dominant age-group on the Buchan grounds between May and July and formed only 18% of the samples, while 3-ringed fish (1954 year-class) made up 54%. This year-class was also the dominant one in the Buchan spawning fishery in August—September and in the fishery on the northerly grounds off Orkney, Fair Isle, and Shetland.

Table 29. Maturity and racial characters — North-western North Sea, 1958

	A. Percentage Maturity (All age-groups) Maturity stage									B. Vert. S. (Actual numbers — all age-groups) Number of vertebrae								
	I	II	III	IV	V	VI	VII	VII-II	Number	54	55	56	57	58	59	60	Mean	Number
Aberdeen																		
May	1.8	**34.6**	0.4	—	—	—	11.2	**52.0**	500	1	22	208	232	28	1	—	56.54	492
June	4.4	**65.0**	12.9	2.8	0.1	0.1	0.4	14.4	800	1	47	299	376	56	2	—	56.57	781
July	3.3	**21.4**	**27.7**	**24.6**	19.3	0.1	0.1	3.6	980	—	24	396	459	54	—	1	56.59	934
August	3.2	5.1	12.1	**24.6**	**27.3**	15.2	5.2	7.3	1023	2	23	438	475	38	—	—	56.54	976
Sept.	3.0	—	7.0	8.0	10.0	8.0	**32.0**	**33.0**	100	—	4	48	40	2	1	—	56.45	95
Fraserburgh																		
May	1.4	**27.2**	0.9	0.6	—	—	**28.3**	**41.6**	346	1	18	119	173	23	2	—	56.61	336
June	3.5	**73.1**	9.8	2.3	0.8	—	0.1	10.5	746	2	18	210	184	18	2	—	56.47	434
July	0.3	10.1	**23.9**	**36.2**	**28.0**	0.3	—	1.1	632	—	8	157	187	19	—	—	56.58	371
August	**19.0**	10.1	**19.8**	**23.2**	**17.1**	6.1	3.0	1.6	672	—	8	141	154	15	1	—	56.56	319
Peterhead																		
May	2.1	**38.9**	2.1	—	—	—	7.4	**49.5**	95	—	6	45	42	1	—	—	56.40	94
June	10.1	**69.0**	7.4	1.3	—	—	0.1	12.1	693	—	12	194	243	29	2	—	56.61	480
July	3.5	16.0	**31.4**	**20.7**	**26.0**	—	0.1	2.3	837	1	10	156	197	19	2	—	56.59	385
August	3.2	4.0	7.1	**22.6**	**28.6**	11.0	7.6	**15.9**	982	1	8	187	194	21	1	—	56.56	412
Lerwick																		
May	2.0	**27.3**	1.4	0.2	0.2	—	**22.0**	**46.8**	440	1	19	174	193	37	2	—	56.59	426
June	1.3	**63.1**	10.9	4.3	1.7	—	0.9	**17.7**	976	—	18	400	464	59	2	—	56.60	943
July	1.1	10.8	**23.6**	**26.1**	**26.3**	0.4	0.5	11.2	1141	1	27	426	581	75	5	—	56.64	1115
August	0.2	5.9	3.5	8.8	**23.6**	5.2	**34.1**	**18.7**	974	1	28	390	480	48	1	—	56.58	948
Sept.	0.7	0.7	2.0	7.3	11.3	12.0	**31.3**	**34.7**	150	—	2	50	85	10	—	—	56.70	147

NORTH – WESTERN NORTH SEA 1958

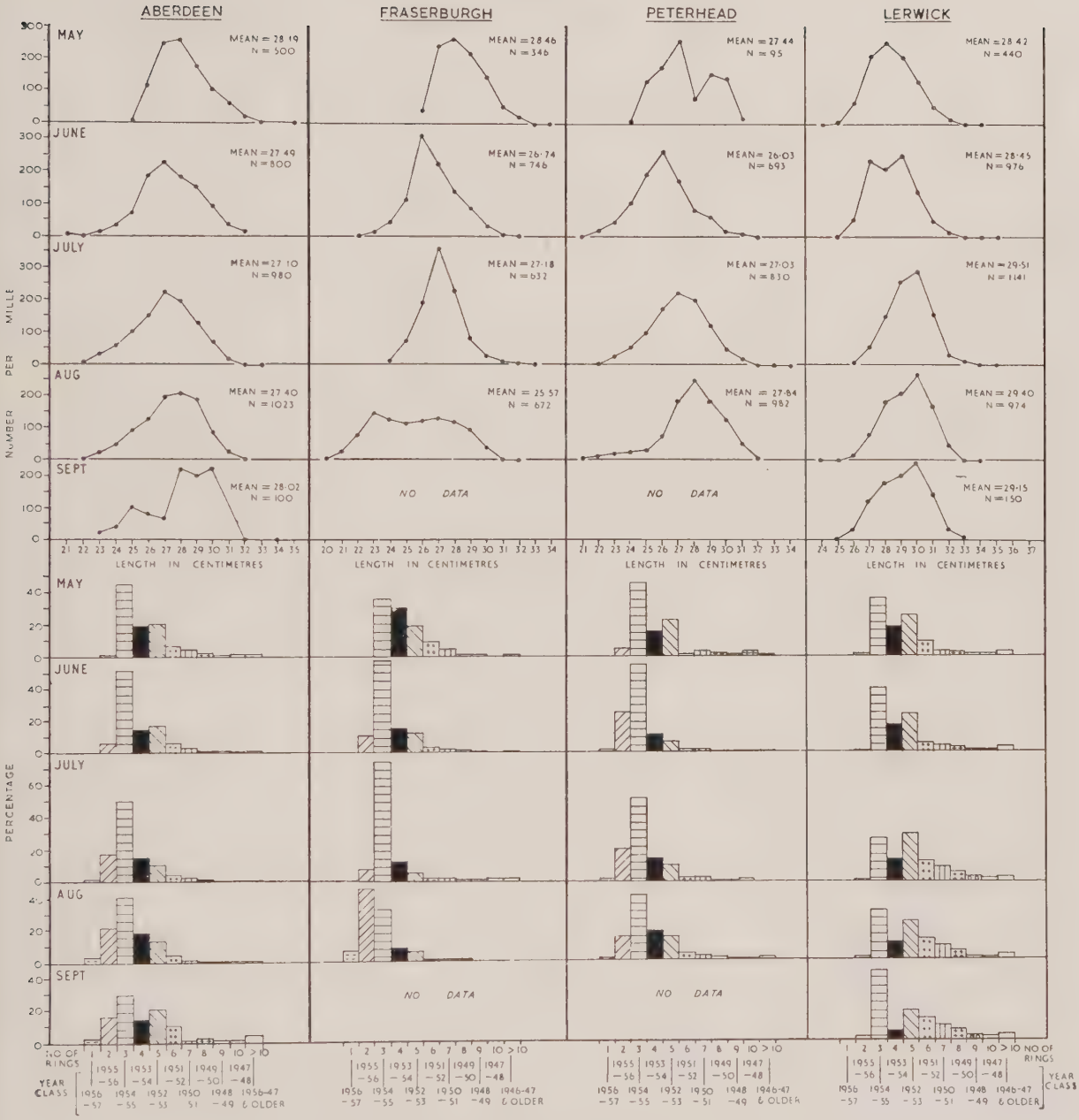


Figure 17. Length and age composition of north-western North Sea drift-net samples May/September 1958. (Length frequencies unsmoothed).

The analysis of the otolith characters of the Lerwick and Aberdeen samples are given in Tables 30 to 33. The Lerwick data for May to July and August—September are given in Tables 30 and 31 and the Aberdeen data from north and south of 59°N during May to July are given in Tables 32 and 33.

These data indicate that the herring fished in the northern regions were of similar composition to those sampled in the north-eastern North Sea in

Table 30. Age composition of spring and autumn spawners at Shetland between May and July 1958

Spring group					Autumn group					Total sample			
										Number		%	
Year-class	Winter-rings	May %	June %	July %	Year-class	Winter-rings	May %	June %	July %	Spring	Autumn	Spring	Autumn
1956	2	1.6	—	—	1955	2	0.3	0.5	0.2	1	7	12.5	87.5
1955	3	24.2	23.3	28.7	1954	3	37.8	42.6	25.7	105	732	12.5	87.5
1954	4	27.4	38.0	26.8	1953	4	16.1	14.1	9.3	122	263	31.7	68.3
1953	5	27.8	20.0	21.5	1952	5	24.7	24.5	30.7	88	577	13.2	86.8
1952	6	8.1	12.4	12.4	1951	6	9.7	5.4	12.1	47	191	19.7	80.3
1951	7	11.3	5.4	8.1	1950	7	2.9	4.3	7.5	31	115	21.2	78.8
1950	8	—	0.8	1.9	1949	8	3.8	2.7	5.4	5	86	5.5	94.5
1949	9	—	—	0.5	1948	9	1.1	1.3	3.6	1	48	2.0	98.0
1948	10	—	–	—	1947	10	1.1	1.3	2.2	—	35	—	100.0
1947 and older	>10	—	—	—	1946 and older	>10	2.7	3.3	3.3	—	68	—	100.0
Total number		62	129	209			373	838	911	400	2122	15.9	84.1

Table 31. Age composition of spring and autumn spawners at Shetland in August and September 1958

Spring Group				Autumn Group				Total Sample			
								Number		%	
Year-class	Winter-rings	Aug. %	Sept. %	Year-class	Winter-rings	Aug. %	Sept. %	Spring	Autumn	Spring	Autumn
1956	2	—	14.3	1955	2	0.6	0.7	1	6	14.3	85.7
1955	3	24.0	14.3	1954	3	32.3	44.1	24	344	6.5	93.5
1954	4	26.0	14.3	1953	4	9.5	4.2	26	89	22.6	77.4
1953	5	24.0	14.3	1952	5	24.0	18.2	24	235	9.3	90.7
1952	6	11.5	42.9	1951	6	12.6	11.2	14	126	10.0	90.0
1951	7	13.5	—	1950	7	8.2	9.1	13	84	13.4	86.6
1950	8	1.0	—	1949	8	4.9	6.3	1	52	1.9	98.1
1949	9	—	—	1948	9	2.5	2.1	—	25	—	100.0
1948	10	—	—	1947	10	1.0	0.7	—	10	—	100.0
1947 and older	>10	–	–	1946 and older	>10	4.4	3.5	—	43	—	100.0
Total number		96	7			871	143	103	1014	9.2	90.8

Table 32. Age composition of spring and autumn spawners in Aberdeen samples from north-western North Sea north of 59°N, May to July 1958

Spring Group					Autumn group					Total sample			
										Number		%	
Year-class	Winter-rings	May %	June %	July %	Year-class	Winter-rings	May %	June %	July %	Spring	Autumn	Spring	Autumn
1956	2	—	—	-	1955	2	1.2	2.8	4.3	—	29	—	100.0
1955	3	23.5	31.1	36.4	1954	3	48.7	49.3	50.8	43	577	6.9	93.1
1954	4	25.0	25.7	36.4	1953	4	17.9	13.3	11.4	40	165	19.5	80.5
1953	5	19.1	20.3	9.1	1952	5	19.7	20.1	12.5	29	205	12.4	87.6
1952	6	17.6	9.5	9.1	1951	6	3.9	7.6	7.1	20	69	22.5	75.5
1951	7	13.2	13.5	9.1	1950	7	2.3	2.4	3.2	20	29	40.8	59.2
1950	8	1.5	—		1949	8	1.9	1.9	2.1	1	22	4.3	95.7
1949	9	—	-	-	1948	9	1.4	0.9	0.7	—	12	—	100.0
1948	10	—	—	—	1947	10	1.6	0.5	0.7	—	11	—	100.0
1947 and older	>10	—	—	—	1946 and older	>10	1.4	1.2	1.1	—	14	—	100.0
Total number		68	74	11			431	422	280	153	1133	11.9	88.1

April and May. The 1954 (3-ringed) and 1952 (5-ringed) year-classes were the dominant ones amongst the autumn spawners in both areas. The spring spawners in both areas were composed mainly of fish with 3 to 7 winter-rings.

On the more southerly Buchan grounds the contribution made by spring spawners was small as is shown in Table 33, and the stock was almost entirely an autumn spawning one. As in recent years the fish on these grounds were younger than

Table 33. Age composition of spring and autumn spawners in Aberdeen samples from north-western North Sea south of 59°N, June and July 1958

Spring group				Autumn group				Total sample			
Year-class	Winter-rings	June %	July %	Year-class	Winter-rings	June %	July %	Number Spring	Number Autumn	% Spring	% Autumn
1957	1	—	—	1956	1	—	1.5	—	9	—	100.0
1956	2	14.3	27.3	1955	2	14.0	22.3	8	169	4.5	95.5
1955	3	50.0	36.4	1954	3	61.3	48.2	15	432	3.4	96.6
1954	4	28.6	13.6	1953	4	10.2	16.8	7	124	5.3	94.7
1953	5	—	9.1	1952	5	11.5	8.2	2	76	2.6	97.4
1952	6	—	4.5	1951	6	2.1	1.5	1	14	6.7	93.3
1951	7	7.1	9.1	1950	7	0.4	0.5	3	4	42.9	57.2
1950	8	—	—	1949	8	0.4	0.2	—	2	—	100.0
1949	9	—	—	1948	9	—	0.2	—	1	—	100.0
1948	10	—	—	1947	10	—	—	—	—	—	—
1947 and older	>10	—	—	1946 and older	>10	—	0.2	—	1	—	100.0
Total number		14	22			235	597	36	832	4.1	95.9

Table 34. Age and length composition — trawled herring 1958

A. Per mille length composition

	Length (cm) 22	23	24	25	26	27	28	29	30	31	32	33	34	Mean	Number
September															
17F	—	—	—	—	20.4	20.4	224.5	183.7	183.7	204.1	163.3	—	—	29.76	49
16H	—	—	—	80.0	20.0	180.0	160.0	280.0	240.0	20.0	20.0	—	—	28.44	50
15E	13.7	6.8	13.7	47.9	95.9	137.0	239.7	137.0	219.2	68.5	6.8	13.7	—	28.23	146
13F	—	104.2	20.8	20.8	20.8	104.2	83.3	270.8	291.7	62.5	20.8	—	—	28.31	48
October															
16F	—	—	—	—	20.0	100.0	80.0	160.0	300.0	200.0	120.0	—	20.0	29.82	50
16H	—	—	20.0	10.0	30.0	120.0	100.0	190.0	280.0	180.0	60.0	—	10.0	29.30	100
15E	—	8.0	16.0	24.0	48.0	196.0	184.0	184.0	160.0	128.0	36.0	16.0	—	28.64	250

B. Percentage age composition

	Number of winter-rings 1	2	3	4	5	6	7	8	9	10	>10	Number
September												
17F	—	2.0	28.6	12.2	16.3	12.2	14.3	4.1	2.0	2.0	6.1	49
16H	—	6.0	48.0	8.0	14.0	6.0	4.0	2.0	2.0	4.0	6.0	50
15E	1.4	13.0	33.6	9.6	15.8	8.9	7.5	3.4	0.7	—	6.2	146
13F	12.5	6.3	27.1	18.8	20.8	4.2	2.1	2.1	2.1	—	4.2	48
October												
16F	—	—	26.0	14.0	28.0	18.0	10.0	2.0	—	—	2.0	50
16H	—	8.0	24.0	8.0	23.0	9.0	8.0	4.0	4.0	2.0	10.0	100
15E	2.8	3.2	38.4	14.8	16.8	11.6	6.8	0.8	1.6	1.6	1.6	250

Table 35. Maturity and racial characters — trawled herring 1958

A. Percentage maturity (all age-groups)

	Maturity Stage I	II	III	IV	V	VI	VII	VII-II	Number
September									
17F	—	**16.3**	**16.3**	12.2	12.2	2.0	**26.5**	14.3	49
16H	—	—	2.0	6.0	8.0	8.0	**32.0**	**44.0**	50
15E	1.4	2.7	1.4	6.2	5.5	7.5	**32.2**	**43.2**	146
13F	10.4	—	2.1	4.2	2.1	10.4	6.3	**64.6**	48
October									
16F	—	8.0	8.0	4.0	—	8.0	8.0	**64.0**	50
16H	—	3.0	6.0	4.0	13.0	16.0	9.0	**49.0**	100
15E	3.2	5.2	4.0	4.0	0.8	1.2	20.0	**61.6**	250

B. Vert. S. (actual number, all age-groups)

	Number of Vertebrae 55	56	57	58	59	Mean	Number
September							
17F	1	19	23	5	—	56.67	48
16H	4	19	24	1	—	56.46	48
15E	5	75	56	7	—	56.45	143
13F	1	13	28	4	—	56.75	46
October							
16F	1	18	30	—	—	56.59	49
16H	3	38	45	3	1	56.57	90
15E	4	103	125	10	—	56.58	242

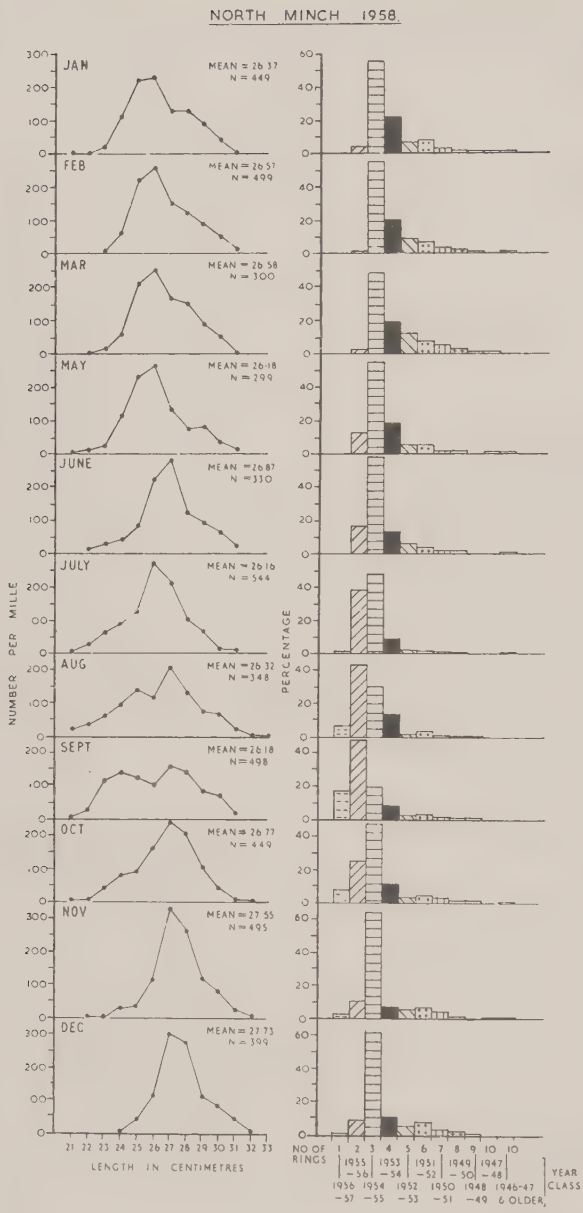


Figure 18. Length and age composition of North Minch drift-net samples January/December 1958. (Length frequencies unsmoothed).

in the more northerly regions and were composed principally of 2- and 3-ringed fish. The 5-ringed 1952 year-class was not prominent in the sampled catch on these grounds.

The lengths of the principal age-groups in the samples from the Buchan grounds were again high as in recent years. This is shown in the following table which gives the mean lengths in centimetres of fish with 2—5 winter-rings for each of the years 1950—1958.

Year	Age (winter-rings) 2	3	4	5
1950	24.51	24.92	26.05	27.73
1951	24.73	25.76	25.93	26.49
1952	24.86	26.25	26.82	27.26
1953	24.54	26.37	27.00	28.09
1954	24.69	26.92	28.12	28.71
1955	24.18	26.81	28.68	29.34
1956	24.76	26.97	28.36	29.43
1957	24.28	26.16	28.30	29.31
1958	24.51	26.76	28.09	28.97

Trawled herring

Samples were taken during September and October from Swedish trawlers fishing over a wide area in the northern North Sea and these samples have been grouped according to the statistical square in each month. The length and age compositions are given in Table 34 and the corresponding maturity and Vert. S. data in Table 35.

The stocks sampled by trawl were very similar to those sampled by drift-net in the north-eastern North Sea in April/May and in the northern regions of the north-western North Sea in later months. Herring with 3 winter-rings were the dominant age-group and 5-ringers were also prominent.

B. West Coast

Minch

In 1958 herring fishing in the Minch was carried out by drift-net and ring-net. Catches were landed mainly at the following ports: Stornoway, Ullapool, and Gairloch in the North Minch, and at Mallaig and Oban in the South Minch. During the summer a small number of drift-net catches from the Minch were also landed at Aberdeen and Fraserburgh by drifters working from these ports.

Drift-net fishing in the North and South Minch was carried out with fair success throughout 1958 but the late autumn and winter fisheries were particularly productive. At those periods large concentrations of recovering spent autumn spawners were located in the Minch.

The landing statistics for the North and South Minch areas are given in Table 36.

The total yield and catch per arrival from the drift-net fisheries were higher than in the three previous years (1955—1957). However, while the overall yield from the ring-net fisheries was higher than in 1957, the average catch per arrival was lower.

Length and age composition data for the North and South Minch samples are given in Figures 18 and 19, and the maturities and Vert. S. are presented in Tables 37 and 38.

Table 36. West coast herring landings, 1955—1958

	North Minch			South Minch		
			Drift-net			
	Landings (crans)	Number of arrivals	Landing per arrival (crans)	Landings (crans)	Number of arrivals	Landing per arrival (crans)
1955	79,557	4,710	16.9	21,605	633	34.1
1956	80,727	4,423	18.3	39,010	971	40.2
1957	114,561	5,285	21.7	11,005	318	34.6
1958	172,006	7,657	22.5	15,907	415	38.3
			Ring-net			
1955	34,781	875	39.7	55,241	4,201	46.0
1956	21,762	774	28.1	50,782	1,125	45.2
1957	20,652	881	23.4	43,466	1,563	27.8
1958	13,485	761	17.7	56,549	2,238	25.3

Table 37. Maturity and racial characters — North Minch 1958

A. Percentage maturity (all age-groups)

Maturity stage	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
I	**14.48**	6.21	10.00	—	**13.04**	**17.87**	**28.13**	**30.75**	**39.76**	**15.14**	4.44	1.25
II	1.78	2.20	1.00	—	**12.37**	**34.55**	**22.61**	**12.36**	**15.86**	6.46	4.04	1.50
III	3.00	2.00	—	—	—	**28.48**	**22.98**	15.23	8.43	3.56	2.02	3.26
IV	7.35	3.41	0.33	—	0.34	6.36	15.81	**20.69**	7.43	1.11	2.42	2.76
V	3.00	3.21	—	—	—	0.91	8.45	16.38	4.22	0.44	0.61	2.01
VI	—	2.40	1.00	—	—	—	—	0.29	0.80	0.44	0.40	0.75
VII	—	0.20	0.33	—	0.68	—	—	0.86	4.02	0.89	0.20	—
VII-II	**70.60**	**80.36**	**87.33**	—	**73.58**	11.82	2.02	3.45	**19.48**	**71.94**	**85.86**	**88.47**
Number	449	499	300	—	299	330	544	348	498	449	495	399

B. Mean Vert. S. for each maturity stage (all age-groups)
(Figures in brackets are numbers of fish)

I	56.73	56.50	56.80	—	56.87	56.90	56.93	56.78	56.48	56.59	56.59	57.00
	(63)	(30)	(30)		(39)	(59)	(150)	(106)	(196)	(68)	(22)	(5)
II	57.25	56.55	57.67	—	56.43	56.47	56.71	56.95	57.12	57.07	56.95	57.00
	(8)	(11)	(3)		(37)	(114)	(121)	(42)	(74)	(29)	(20)	(6)
III	57.09	57.10	—	—	—	56.60	56.57	56.48	56.76	56.94	57.00	57.08
	(11)	(10)				(92)	(124)	(52)	(42)	(16)	(10)	(13)
IV	57.09	56.76	57.00	—	57.00	56.71	56.56	56.54	56.69	56.60	57.10	57.09
	(42)	(17)	(1)		(1)	(21)	(84)	(71)	(35)	(5)	(10)	(11)
V	57.08	57.00	—	—	—	56.33	56.62	56.33	56.19	56.50	57.33	56.75
	(13)	(15)				(3)	(45)	(55)	(21)	(2)	(3)	(8)
VI	—	57.18	56.67	—	—	—	—	56.00	57.00	56.50	57.50	56.33
		(11)	(3)					(1)	(3)	(2)	(2)	(3)
VII	—	57.00	56.00	—	57.00	—	—	56.33	56.60	56.75	56.00	—
		(1)	(1)		(2)			(3)	(20)	(4)	(1)	
VII-II	56.49	56.55	56.55	—	56.55	56.82	56.91	56.75	56.61	56.60	56.56	56.56
	(295)	(398)	(259)		(211)	(39)	(11)	(12)	(99)	(314)	(420)	(350)
Overall mean	56.64	56.60	56.59	—	56.58	56.64	56.71	56.63	56.71	56.64	56.60	56.60
	(442)	(493)	(297)		(290)	(328)	(535)	(342)	(481)	(440)	(488)	(396)

The North Minch data are from drift-net catches and the South Minch data from ring-net catches.

The maturities and Vert. S. data show that, as in previous years, the herring population in the Minch was composed of a mixture of spring and autumn spawners. This is confirmed by the data given in Tables 39 and 40 which show the results obtained by analyses of otolith characters.

In both regions autumn spawners predominated in the catches throughout the year but in the North Minch the spring spawners formed a much more important part of the catch during the summer than in the late autumn and winter when the fishery was most productive.

Age composition data indicate that in the North Minch 3-ringed herring of the 1954—55 year-class

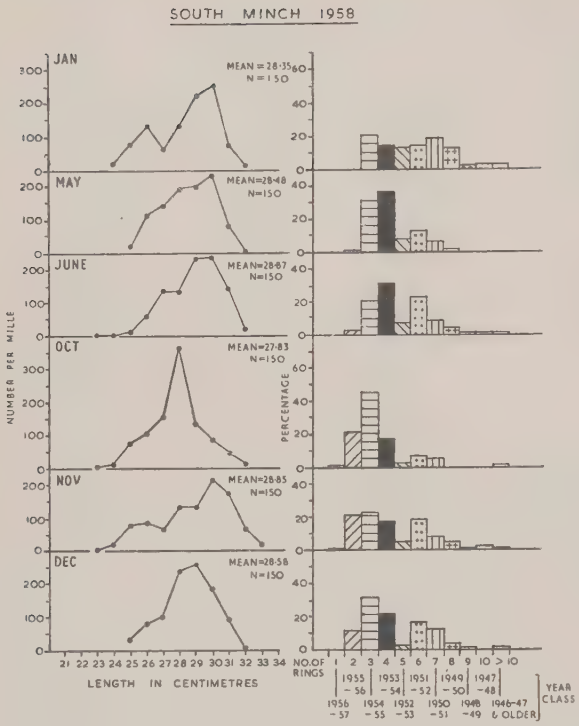


Figure 19. Length and age composition of South Minch ring-net samples January/December 1958. (Length frequencies unsmoothed).

Table 38. Maturity and racial characters — South Minch 1958

A. Percentage maturity (all age-groups)

Maturity stage	Jan.	May	June	Oct.	Nov.	Dec.
I	3.33	4.00	4.67	7.33	9.33	1.33
II	0.67	12.67	12.00	3.33	2.67	0.67
III	—	—	—	0.67	6.00	1.33
IV	2.00	—	—	0.67	3.33	—
V	1.33	—	—	—	—	0.67
VI	—	—	—	0.67	8.67	—
VII	—	—	0.67	14.67	10.67	2.67
VII–II ..	**92.67**	**83.3**	**82.67**	**70.67**	**59.33**	**93.33**
Number .	150	150	150	150	150	150

B. Mean Vert. S. for each maturity stage (all age-groups)
(Figures in brackets are number of fish)

I	56.40 (5)	56.67 (6)	57.00 (7)	56.64 (11)	56.36 (14)	56.00 (2)
II	57.00 (1)	56.82 (17)	56.44 (18)	57.00 (5)	57.25 (4)	56.00 (1)
III	—	—	—	56.00 (4)	57.00 (9)	57.50 (2)
IV	57.00 (3)	—	—	56.00 (1)	57.00 (5)	—
V	57.00 (2)	—	—	—	—	58.00 (1)
VI	—	—	—	57.00 (1)	56.77 (13)	—
VII	—	—	57.00 (1)	56.50 (22)	56.20 (15)	56.25 (4)
VII–II ..	56.60 (137)	56.71 (124)	56.57 (123)	56.46 (105)	56.51 (89)	56.50 (139)
Overall mean ..	56.61 (148)	56.72 (147)	56.58 (149)	56.51 (149)	56.55 (149)	56.50 (149)

Table 39. Percentage of spring and autumn spawners — North Minch 1958

Period		Jan.–March	%		May–June	%		July–September	%		October–December	%	
Year-class	Rings	Number	Spring	Autumn	Number	Spring	Autumn	Number	Spring	Autumn	Number	Spring	Autumn
1956–57	1	—	—	—	—	—	—	110	92.7	7.3	43	76.7	33.3
1955–56	2	36	100.0	0	101	63.2	37.6	593	49.2	50.8	218	32.6	67.4
1954–55	3	663	5.9	94.1	386	3.6	96.4	463	9.7	90.3	753	5.2	94.8
1953–54	4	253	26.1	73.9	103	23.3	76.7	129	39.5	60.5	124	18.5	81.5
1952–53 and older	> 4	289	4.8	95.2	89	3.4	96.6	84	3.6	96.4	202	3.0	97.0
Total		1,241	12.5	87.5	629	15.9	84.1	1,397	35.1	64.9	1,340	12.8	87.2

Table 40. Percentage of spring and autumn spawners — South Minch 1958

Period		January	%		May–June	%		October–December	%	
Year-class	Rings	Number	Spring	Autumn	Number	Spring	Autumn	Number	Spring	Autumn
1956–57	1	—	—	—	—	—	—	3	66.7	33.3
1955–56	2	—	—	—	6	50.0	50.0	81	19.8	80.2
1954–55	3	30	—	100.0	78	16.7	83.3	148	5.4	94.6
1953–54	4	21	9.5	90.5	82	30.5	69.5	83	19.3	80.7
1952–53 and older	> 4	99	3.0	97.0	164	—	100.0	135	3.7	96.3
Total		150	3.3	96.7	300	13.7	86.3	450	10.4	89.6

Table 41. Scottish herring tagging 1958

Liberation			Recapture		
Area	Period	Number	Area	Number	Days at liberty
Lea Tag					
Shetland	June–July	222	Fladen	1	70
Buchan	June–July	282	Fladen	3	7–14
			Gut	1	40
			NE England	1	62
Scottish Combination Tags					
Upper Moray Firth	November	35	Upper Moray Firth	2	22–31

predominated in all months except August and September when the 2-ringed recruit age-group (1955—56 year-class) was most abundant. The racial data show that the 3-ringed herring were predominantly autumn spawners while the 2-ringed recruits were composed of a mixed stock of spring and autumn spawned fish.

In the South Minch during the sampling periods spring spawners were rather less prominent than in the northern region. The autumn spawners in this region contained a rather higher proportion of the older age-groups than in the north.

C. Tagging

Only 359 herring were tagged in the north-western North Sea in 1958. The details of liberation and recapture are given in Table 41.

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The Herring Fisheries of the Netherlands in 1958

(Figure 20; Charts 23–38; Table 42 A and B)

Trawl fisheries

Since detailed information on the trawl fisheries is nowadays given in the *Statistical News Letters*, publication of the charts, showing the catch per effort and the effort exerted will be discontinued for the herring trawl fishery. Information will now be restricted to a short review of the fishery in the year under consideration.

In 1958 some 35,700 tons of trawled herring from the North Sea and English Channel were landed in the Netherlands, against 40,000 tons in 1957. The total effort exerted, expressed in hours fishing of a standard motor trawler of 500 B.H.P., was 170,000 hours (1957: 161,000 hours).

In addition to the North Sea catch 5,300 tons of herring were landed from the area to the SE of Ireland (Smalls and Dunmore area), against 3,400 tons in 1957. Pair trawlers, working in the Sandettié area and in the eastern English Channel, landed 1,200 tons (1957: 1,300 tons). The monthly catches of trawled herring are given in Table 42 B.

In the NE North Sea (Viking Bank, Utsira, Patch) fishing was extraordinarily favourable in the spring, especially in February/March. In this area fishing was carried out throughout the year, yielding a total catch of 14,500 tons (1957: 7,600 tons) with an effort exerted of 97,000 hours fishing (1957: 92,000 hours). The catch per 100 hours fishing increased from 8.4 tons in 1957 to 14.0 tons in 1958.

In the NW North Sea (Fladen, Gut) fishing was less successful than in 1957. The total catch decreased from 15,000 tons in 1957 to 9,900 tons in 1958. The total effort was 42,000 hours fishing in 1957, against 45,000 hours fishing in 1958. The catches per 100 hours fishing dropped from 36 tons in 1957 to 22 tons in 1958.

In the central North Sea too, fishing was less profitable than in 1957. The total catch amounted to 10,300 tons (1957: 14,800 tons) with an effort of 31,000 hours fishing (1957: 23,000 hours). The catch per 100 hours fishing decreased from 66 tons in 1957 to 34 tons in 1958.

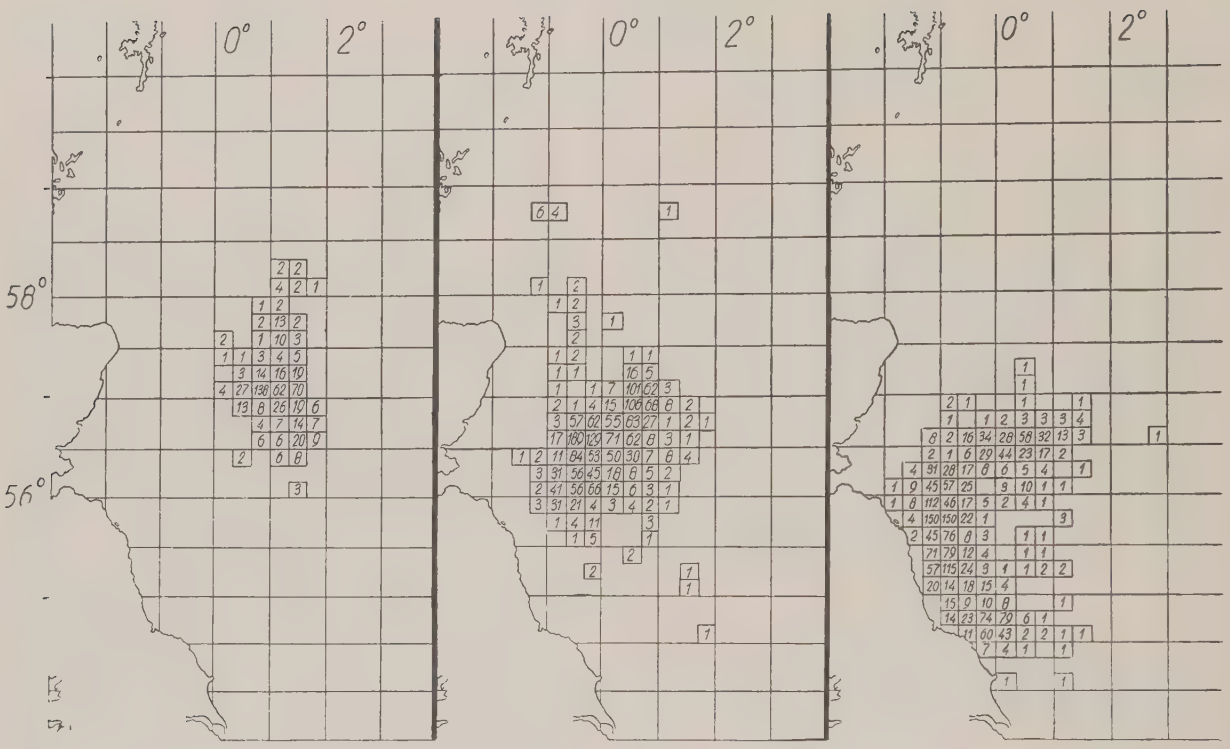
Again, fishing in the southern North Sea (Sandettié and eastern English Channel) was very unsatisfactory. The fishing in the eastern English Channel gave especially poor results, inducing the trawlers to leave the area at an early date. The total catch was some 830 tons (1957: 2,500 tons) with an effort exerted of approximately 1,100 hours trawling (1957: 3,000 hours). The catch per 100 hours fishing was 74 tons, against 78 tons in 1958.

Fishing in the area to the SE of Ireland was very good in the Dunmore region in the month of January, but the results of the December fishing were decidedly poorer. Detailed data of the effort in this area are lacking.

Drift-net fisheries

Apart from an insignificant fishery carried out in April in the NE North Sea, the drift-net fishery was restricted to the period from May to December, inclusive. The total catch, made in the North Sea and eastern English Channel, amounted to

Number of Hauls

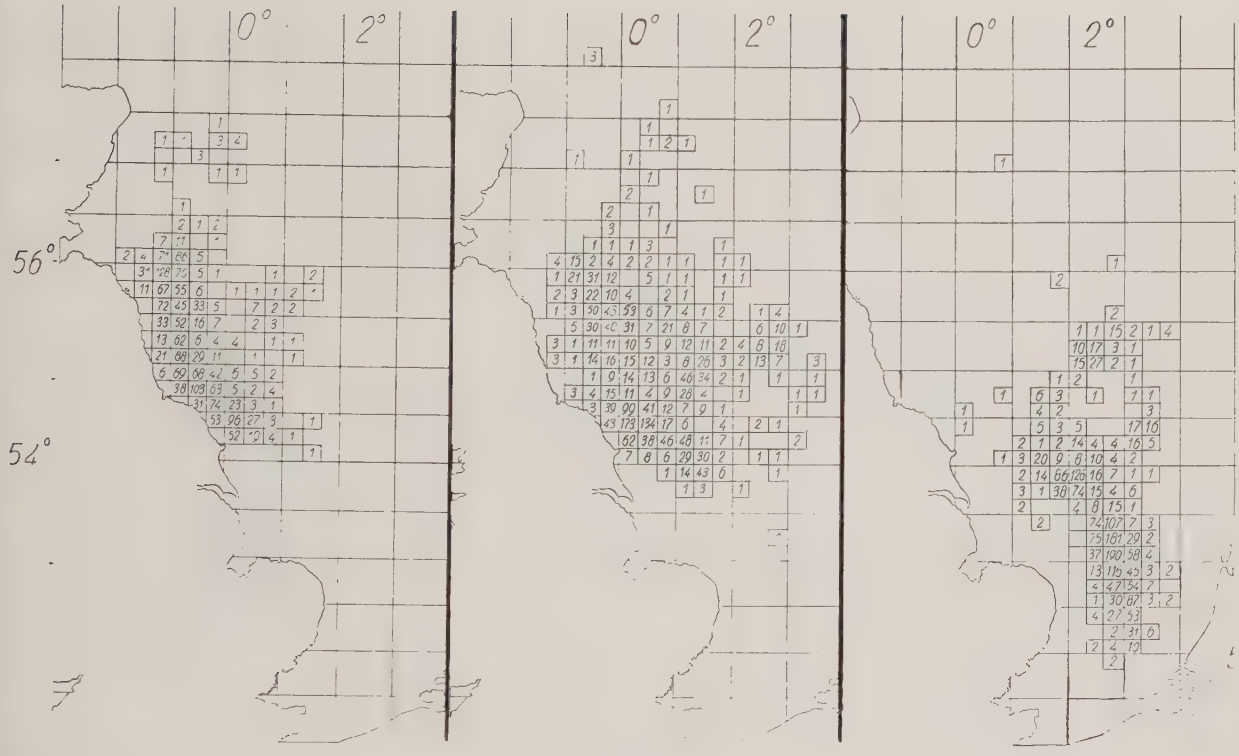


Charts 23–25. May June July

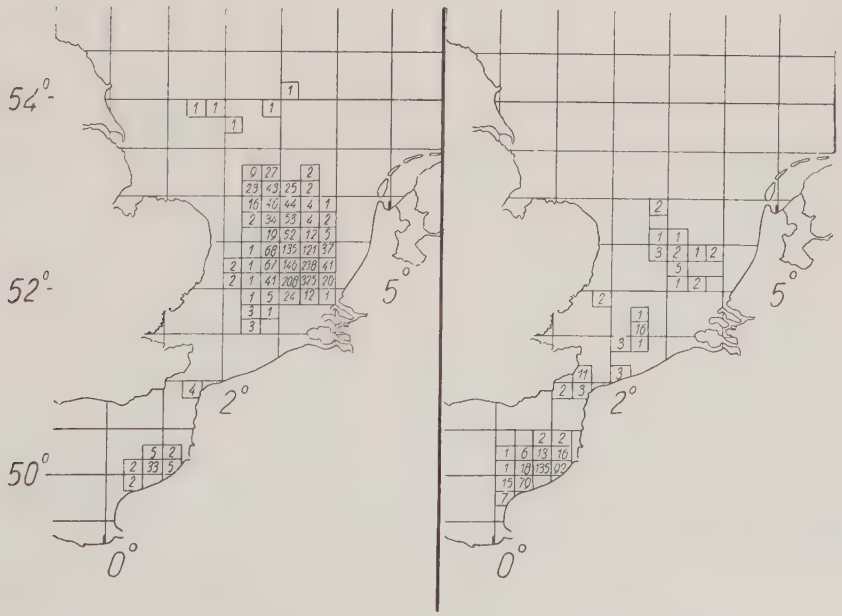
Table 42. Quantities of herring landed in Dutch Ports in 1958

	A. Landed by luggers fishing with drift-nets					B. Trawled Herring (in tons)	
		Salted herring (in kantjes)			Fresh herring (in kg)		
	Matjes	Gutted full	Spent	Ungutted		Trawlers and luggers	All kinds of vessels
January	—	—	—	241	—	3,206	3,729
February	—	—	—	—	—	1,079	1,111
March	—	—	—	—	—	3,277	3,422
April	—	—	—	2,744	30,120	600	600
May	8,326	—	—	2,178	28,675	959	959
June	59,397	—	—	12,030	1,777,503	1,421	1,421
July	50,808	1,019	—	15,238	1,587,090	4,599	4,607
August	24,299	30,238	1,200	12,542	2,999,030	5,236	5,276
September	10,126	22,696	5,431	4,254	230,305	9,128	9,165
October	349	25,088	2,621	57,677	833,775	6,196	6,231
November	—	14,700	337	108,665	531,030	4,198	4,470
December	—	547	30	25,580	14,775	1,118	1,307
Total 1958	153,305	94,288	9,619	241,149	8,032,303	41,017	42,298

Number of Hauls

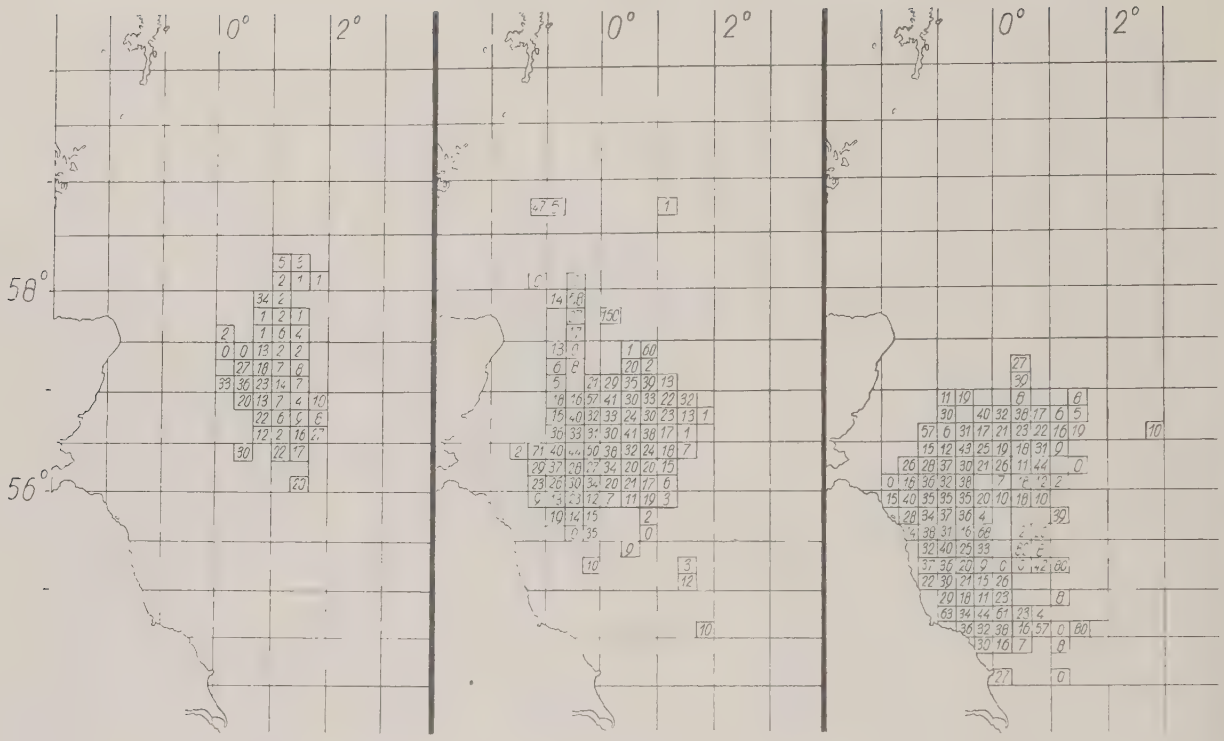


Charts 26–28. August September October



Charts 29–30. November December

Mean Catch per Haul (Kantjes)



Charts 31–33. May June July

57,800 tons (1957: 55,900 tons). The monthly catches are given in Table 42 A.

The distribution of catches and effort may be derived from the Charts 23—38, Charts 23—30 show the monthly distribution of the shots, whereas Charts 31—38 present the mean catch per shot. It should be noticed, however, that all these data do not present the total drift-net catch, but only that part about which detailed information was available. The total drift-net catch will be accounted for in the *Statistical Newsletters* 1958, estimated by raising the part shown here to the monthly total catches.

Fishing started on 19. May and ended on 18. December. From 19. May to 27. May 60 nets were shot, after this date the drift-nets were composed of 100—120 nets. Contrary to 1957, the summer fishery was carried out mainly in the central and southern section of the summer feeding grounds of the herring. Catches were generally good, especially in the south.

The late summer and autumn fishery, carried out in the central North Sea, gave moderate results only, as has been usual in the last few years.

The East Anglian season was decidedly disappointing. The average catch per shot was the lowest recorded since the war, being 3.6 tons (1957: 4.8 tons) (a ton has been calculated here as 10 kantjes). Drift-net fishing in the English Channel was as usual of little significance and yielded rather poor results.

As a whole the 1958 drift-net fishing was slightly better than that of 1957.

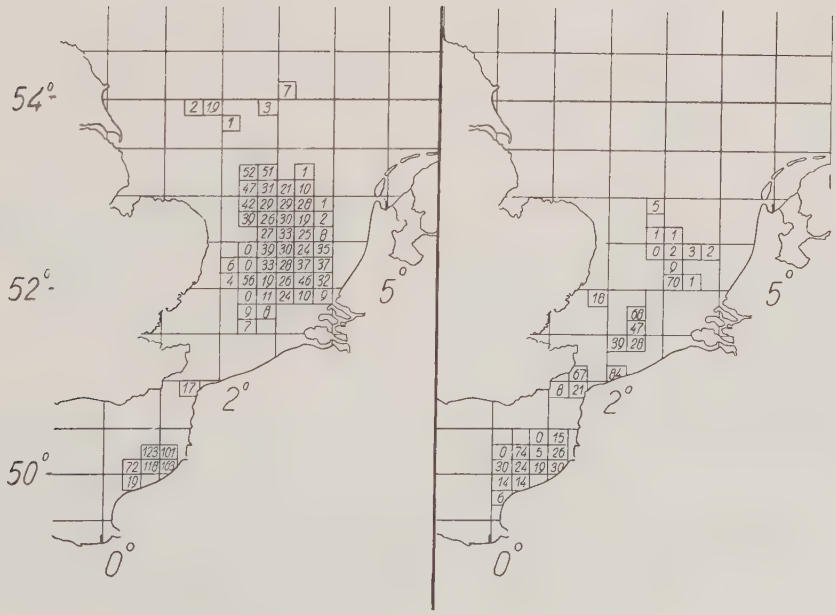
Age compositions

As in former years, some commercial sampling was carried out. For the trawl fishery, sampling was restricted to the spawning areas. Samples. were collected from the trawl fishery on the SW Dogger Bank (September—October), in the Sandettié area (November), in the eastern English Channel (December), and from the Dunmore fishery on the SE coast of Ireland (December 1958 and January 1959).

The age compositions, shown in Figure 20, are based on herring in maturity stage VI only. It may be noticed, that the year-class 1952 (6 year-old) is still of considerable importance in the Dogger area. Recruitment was fairly good in this area.

Mean Catch per Haul (Kantjes)

Charts 34–36. August September October



Charts 37–39. November December

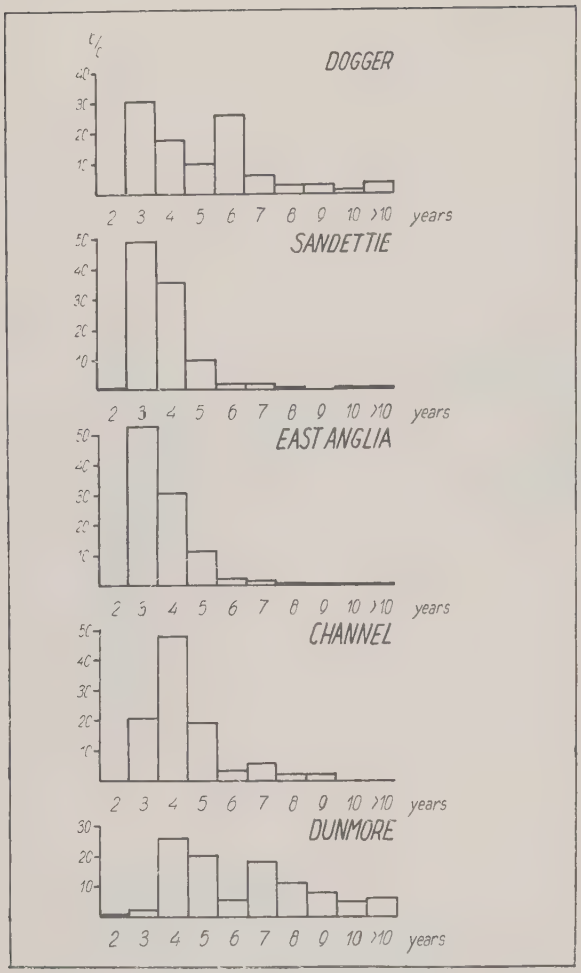


Figure 20. Age composition of spawning herring in the Dogger, Sandettié, English Channel, and Dunmore areas (herring trawl), and from the drift-net fishery in the southern North Sea.

The Sandettié and eastern English Channel show a marked lack of older herring, as has been customary in the last few years. Unusually great is the difference between the two age compositions presented, the eastern English Channel showing relatively few recruits. This may, however, be attributable to inadequate sampling, since only two samples could be collected due to the limited fishing in the area.

The most striking feature of the age composition in the Dunmore area is the almost complete absence of recruits. This failure of recruitment may cause a rather poor fishery in this area in the 1958/1959 season.

Market measurements, combined with a limited age sampling, were carried out for the drift-net fishery in the southern North Sea (East Anglian region). The age composition, calculated from this material is presented in Figure 20.

It reveals the normal picture of the age composition in this region in the last few years, the herring over 5 years of age being very scarce, indeed.

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The Belgian Herring Fishery in 1958—1959

(Tables 43–55)

A. The Fishery

As in 1957/58, it became apparent early in the 1958/59 herring season that it would not be very encouraging. So much so, that only few trawlers decided to take part in it. In consequence, the landings of herring dropped to a level far lower than 1957/58, and these catches were in comparison with those of the preceding seasons already markedly on the decrease. Owing to the lack of remunerative catches, the herring fishery was constantly on the move and the fishing grounds visited were rather dispersed and thus rarely and very irregularly fished.

Two different kinds of trawl were used — the otter-trawl and the pelagic pair trawl. The results obtained by these two fishing methods are given separately.

I. Otter-trawl: regions/periods

Six regions were exploited:—

(1) The region S and SW of the Shetlands — July, August, November.
(2) Utsira Patch and Coral Bank — August, September, October.
(3) Brucey's Garden — September, October.
(4) The Sandettié region — November.
(5) The region S and SW of Ireland — August to November.
(6) The region N of Ireland — October to December.

Fishing effort and landings

Tables 43—45 give records of the fishing effort and the yield of the fishery. Ten trawlers made 46 trips and developed 1,920,930 FH x h. p. In 1957/58 14 trawlers made 66 trips and developed 3,313,650 FH x h. p. (Table 43).

A total weight of 1,234 tons was landed of which 805 tons were herring (65.3%), 195 tons were other pelagic fish (15.8%) and 234 tons were demersal fish (18.9%) (Table 44).

Table 43. Otter-trawl: number of trips and fishing effort

Months	S and SW Shetlands	Utsira Coral Bank	Brucey's Garden	Sandettié	S and SW Ireland	North Ireland	Total
			Number of trips				
July	2	—	—	—	—	—	2
August	2	1	—	—	1	—	4
September	—	1	1	—	10	—	12
October	—	1	—	—	12	5	18
November	1	—	—	1	6	1	9
December	—	—	—	—	—	1	1
Total 1958	5	3	1	1	29	7	46
			Fishing effort (1,000 FH x h.p.)				
July	69	—	—	—	—	—	69
August	62	37	—	—	65	—	164
September	—	60	28	—	485	—	573
October	—	51	—	—	555	121	727
November	39	—	—	10	238	53	340
December	—	—	—	—	—	48	48
Total 1958	170	148	28	10	1,343	222	1,921

Table 44. Otter-trawl: total yields

Species	S and SW Shetlands		Utsira Coral Bank		Brucey's Garden		Sandettié		S and SW Ireland		North Ireland		Total	
	Tons	‰	Tons	‰	Tons	‰	Tons	‰	Tons	‰	Tons	‰	Tons	‰
Pelagic														
Herring	51.6	356	14.6	142	20.6	697	4.3	850	523.1	708	191.1	896	805.3	653
Mackerel	57.8	400	43.5	422	0.9	29	—	—	77.5	105	4.7	22	184.4	149
Others	—	—	—	—	—	—	0.3	60	9.8	13	0.4	2	10.5	9
Total	109.4	756	58.1	564	21.5	726	4.6	910	610.4	826	196.2	920	1,000.2	811
Demersal														
Haddock	13.8	96	14.1	137	—	—	—	—	0.1	0	1.5	7	29.5	24
Cod	3.9	27	5.9	57	3.0	103	—	—	10.6	14	2.6	12	26.0	21
Saithe	1.3	9	10.6	103	—	—	—	—	22.2	30	6.5	31	40.6	33
Whiting	9.5	66	9.1	88	4.8	162	0.2	45	61.2	83	1.7	8	86.5	70
Others	6.8	46	5.2	41	0.3	9	0.2	45	34.3	47	4.7	22	51.5	41
Total	35.3	244	44.9	436	8.1	274	0.4	90	128.4	174	17.0	80	234.1	189
Grand Total	144.7	1000	103.0	1000	29.6	1000	5.0	1000	738.8	1000	213.2	1000	1,234.3	1000

In the previous season 1,942 tons of herring were landed, this being 1,137 tons or 58.3% more than in 1958/59. The average catch per trip for all regions together reached 17.5 tons and per 100 FH x h. p. 41 kg. In 1957/58 these figures were 28.5 tons and 59 kg respectively (Table 45).

II. Pelagic pair trawl: region/period

The use of the pelagic trawl was localized to the region covering the Hinders Banks and the eastern English Channel. The first catches were landed on October 23rd, 1958 and the last on February 11th, 1959.

Fishing effort and landings

Table 46 gives a survey of the fishing effort. This year, 9 pairs of boats took part in the fishery, but only 7 of them fished regularly, the remaining two doing only one trip each. A total of 164 voyages were made and 70,554 V x h. p. (V = voyages) were developed. In 1957/58, 11 pairs made 183 voyages and developed 67,660 V x h. p.

The total catch amounted to 1,332 tons, consisting of 1,221 tons of herring (91.8%), 84 tons of other pelagic fish (6.2%) and 27 tons of demersal fish (4%) (Table 47). The previous season 1,367 tons of herring were landed.

The average catch per voyage reached 7.4 tons and per 100 V x h. p. 1,731 kg; during 1957/58, 7.4 tons and 2,020 kg respectively (Table 48).

Table 45. Otter-trawl: yields of herring

Months	S and SW Shetlands	Utsira Coral Bank	Brucey's Garden	Sandettié	S and SW Ireland	North Ireland	Total
			Total catch (tons)				
July	25	—	—	—	—	—	25
August	16	3	—	—	12	—	31
September	—	3	21	—	238	—	262
October	—	9	—	—	196	161	366
November	11	—	—	4	76	24	115
December	—	—	—	—	—	6	6
Total 1958	52	15	21	4	522	191	805
			Average catch per trip (tons)				
July	12.4	—	—	—	—	—	12.4
August	7.9	3.2	—	—	11.9	—	7.7
September	—	2.7	20.6	—	23.9	—	21.9
October	—	8.7	—	—	16.4	32.2	20.4
November	10.9	—	—	4.2	12.7	24.3	12.8
December	—	—	—	—	—	5.6	5.6
Total 1958	10.3	4.9	20.6	4.2	18.0	27.3	17.5
			Average catch per 100 FH x h.p. (kg)				
July	36	—	—	—	—	—	36
August	25	9	—	—	18	—	18
September	—	5	73	—	49	—	46
October	—	17	—	—	35	133	50
November	28	—	—	43	32	46	34
December	—	—	—	—	—	12	12
Total 1958	33	10	73	43	39	86	41

Table 46. Pelagic pair trawl: number of trips and fishing effort

Months	Number of trips	Fishing effort (1,000 V x h. p.)
October	8	3.4
November	72	31.5
December	64	27.5
January	15	6.4
February	5	1.7
Total 1958–59	164	70.5

Table 48. Pelagic pair trawl: yields of herring

Months	Total catch (tons)	Average catch per voyage (tons)	Average catch 100 V x h.p. (kg)
October	29	3.6	827
November	678	9.4	2,154
December	367	5.7	1,336
January	115	7.7	1,804
February	32	6.4	1,852
Total 1958–59	1,221	7.4	1,731

Table 47. Pelagic pair trawl: total yields

Species	Tons	‰
Pelagic		
Herring	1,221	918
Mackerel	—	—
Pilchard	70	52
Others	14	10
Demersal		
Cod	8	6
Whiting	11	8
Others	8	6
Total pelagic species	1,305	980
Total demersal species	27	20
Grand Total	1,332	1,000

B. The Herring Stock

A total of 2,615 herring were investigated; they were collected on Utsira Patch and Coral Bank (180 — October), the Brucey's Garden (75 — September), the Sandettié (990 — October to December), off the Belgian coast (150 — December/January), off Boulogne (430 — December/January) and South Ireland (790 — September to November).

Table 49 shows the size composition of the herring for each fishing area. The average weight and the percentage number of males is also recorded as is the average size of the fish.

Table 50 gives the stages of maturity for these areas.

As in previous years the quantity of intestinal fat was estimated, and the results are shown in Table 51.

The age composition of the catches is shown in Table 52. The 4 year-old fish were predominant in all areas, excepting the area off the Belgian coast, where the 3 year-olds were dominant (717‰).

Table 49. Size, weight and sex (‰)

Cm	Utsira Patch	Brucey's Garden	Sandettié	Belgian coast	Boulogne	South Ireland
34	6	—	—	—	—	—
33	11	—	—	—	—	—
32	39	—	—	—	—	—
31	121	—	2	—	—	1
30	**172**	53	8	—	28	23
29	117	120	24	7	49	80
28	117	67	56	7	77	**209**
27	56	107	119	7	158	206
26	100	**187**	225	80	**260**	159
25	83	93	**258**	126	207	52
24	100	53	193	246	137	20
23	50	107	89	**360**	65	27
22	28	120	24	107	14	62
21	—	67	2	33	5	105
20	—	13	—	20	—	53
19	—	13	—	7	—	3
Total	1000	1000	1000	1000	1000	1000
Average length, mm	282	258	258	240	263	261
Mode, cm	30	26	25	23	26	28
Weight, g	177	155	138	92	122	164
Males ‰	506	440	442	413	449	466

Table 50. Stages of maturity (‰)

Stages	Utsira Patch	Brucey's Garden	Sandettié	Belgian coast	Boulogne	South Ireland
I	11	266	15	40	16	199
II	—	—	4	13	12	11
III	11	107	—	—	2	56
IV	22	147	5	—	—	170
V	406	**360**	**513**	20	47	**519**
VI	111	—	196	—	5	1
VII	—	—	10	—	9	—
VIII–II	**439**	120	257	**927**	**909**	44
Total	1000	1000	1000	1000	1000	1000

Table 51. Quantity of intestinal fat (‰)

Quantity	Utsira Patch	Brucey's Garden	Sandettié	Belgian coast	Boulogne	South Ireland
0	17	53	113	87	135	72
1	**922**	**374**	**824**	**860**	**828**	**553**
+	50	293	46	53	23	279
M	11	280	17	—	14	96
Total	1000	1000	1000	1000	1000	1000
Index	2.06	2.80	1.97	1.97	1.92	2.40

Table 52. Age (‰)

Age	Year-class	Utsira Patch	Brucey's Garden	Sandettié	Belgian coast	Boulogne	South Ireland
2	1956	—	44	5	62	8	120
3	1955	125	130	308	**717**	154	37
4	1954	**161**	**348**	**458**	172	**508**	**329**
5	1953	89	130	147	35	189	176
6	1952	143	261	26	—	39	88
7	1951	**161**	—	26	14	39	125
8	1950	89	44	18	–	39	56
9	1949	89	—	2	—	16	37
10	1948	107	—	3	—	8	23
+10	<1948	36	43	7	—	—	9
Total		1000	1000	1000	1000	1000	1000
Average age (years-months)		6.6	4.11	4.1	3.3	4.6	5.0

Table 53. Average lengths by age and the value of L_1 (mm)

Average length by age in mm

Brood	Utsira Patch	Brucey's Garden	Sandettié	Belgian coast	Boulogne	South Ireland
1956	—	212	235	217	239	219
1955	247	233	245	237	247	238
1954	270	268	261	252	262	269
1953	289	271	274	260	274	279
1952	300	295	284	—	286	285
1951	302	—	290	287	292	288
1950	307	295	299	—	295	290
1949	308	—	313	—	301	300
1948	312	—	294	—	296	299

Average value of L_1 in mm

L_1	Utsira Patch	Brucey's Garden	Sandettié	Belgian coast	Boulogne	South Ireland
1956	—	138	155	137	124	146
1955	142	133	138	129	143	120
1954	127	121	123	116	123	126
1953	142	136	127	116	124	130
1952	133	129	131	—	137	135
1951	126	—	139	120	137	132
1950	137	99	135	—	123	121
1949	145	—	102	—	119	114
1948	118	—	109	—	112	145

Table 54. Vertebrae (V.S. ‰)

V.S.	Utsira Patch	Brucey's Garden	Sandettié	Belgian coast	Boulogne	South Ireland
61	—	—	–	–	—	1
60	—	–	–	—	–	—
59	—	—	1	–	—	9
58	65	42	56	35	72	94
57	**506**	**486**	**478**	**479**	**522**	**581**
56	422	347	404	472	382	291
55	7	125	55	14	24	23
54	–	—	6	—	—	1
Total	1000	1000	1000	1000	1000	1000
Average	56.630	56.444	56.526	56.535	56.643	56.775
Standard error	0.6153	0.7614	0.7169	0.5894	0.6505	0.6985
Fluctuation mean	0.1310	0.3024	0.0785	0.1668	0.1078	0.0849

Table 55. Keeled scales (K_2) in ‰

K_2	Utsira Patch	Brucey's Garden	Sandettié	Belgian coast	Boulogne	South Ireland
19	—	—	2	—	—	—
18	12	—	5	—	5	—
17	17	41	19	27	9	10
16	109	68	170	134	128	50
15	**442**	**425**	**458**	**450**	**496**	**450**
14	270	315	287	288	317	422
13	144	151	54	101	45	59
12	6	—	5	—	—	9
Total	1000	1000	1000	1000	1000	1000
Average	14.603	14.534	14.823	14.698	14.754	14.504
Standard error	1.0142	0.9670	0.9168	0.9185	0.8039	0.7641
Fluctuation mean	0.2591	0.3819	0.0987	0.2537	0.1318	0.0990

The average length of the herring and the growth rate during the first year (L_1) is given in Table 53.

The number of vertebrae observed per spine varies between 54 and 61 (Table 54). The spines with 57 vertebrae predominate.

Finally Table 55 gives the number of keeled scales (K_2) for each fishing ground.

Stomach analyses were made on all herring investigated. Only 36 stomachs were found to contain food, mostly remains of copepods.

C. Conclusions

The fact of the herring catches undergoing once again a marked decrease is most probably caused mainly by the increasing impoverishment of the herring stocks. The abnormal composition of the catches, as regards the year-classes, corroborates once more this opinion.

The analysis of the herring samples would tend to show that in the southern North Sea, the 3 and 4 year-old herring were represented in the catches with 766‰ and in the eastern English Channel with 662‰. Herring concentrations where these two young year-classes predominate in such an excessive measure are poor and their large representation is an ill omen for the success of the future herring campaigns in both regions.

The herring catches from the other areas were to a great extent (19% to 53%) composed of demersal fish, so much so that the fishery was in fact a mixed one instead of a pure herring fishery.

The material originating from these areas was either not available or insufficient to draw any valid conclusions.

Ch. Gilis

Polish Investigations of Herring in 1958

The age and length compositions of herring in Polish trawl catches in the Farn Deep/East Bank area (statistical rectangles D, E — 9, 10) in August and September 1958 were as follows:—

Length distribution (‰)

cm	18	19	20	21	22	23	24	25
	1	13	36	91	168	187	102	87
cm	26	27	28	29	30	31	32	
	87	84	52	36	36	16	4	

Total number = 5,204

Age composition (‰)

Years	2	3	4	5	6	7	8	9	10	10+
	501	207	151	43	47	18	18	7	13	5

Total number = 878

The catches consisted mainly of 2 year-old herring of the 1956 year-class. The 1955 year-class was poor. The 2 year-old herring were very large; the mean length of these fish in the rectangles D, E — 9, 10 was 22.11 cm; in F — 9, 10, 21.58 cm; in G — 9, 10, 20.19 cm. These values may be compared with the results of the measurements made during the tagging experiments of the ICES on the Bløden Ground in 1958. The corresponding means, calculated from the Report, Part IV are: rectangles H — 8, 9, 18.12 cm; J — 8, 17.12 cm; K — 11, 10, 8, 16.68 cm; and L — 10, 16.40 cm.

In 1958 the length of young herring has shown a distinct decreasing tendency from west to east.

J. Popiel

ICES Herring Tagging Experiment on the Bløden Ground 1958

(Figure 21; Tables 56–57)

The second international tagging experiment on the Bløden Ground was carried out during July—August 1958 under the administration of ICES.

The aims of the experiment were:—

1. To check the results of the 1957 experiment as to the effect of the industrial fishery of Denmark and Germany upon the stock of immature herring. As in 1957, the method applied was internal tagging on purse-seine caught herring using the Norwegian internal 25 mm iron tag.

2. To obtain information on the movements of the young herring after they have left the Bløden Ground area, by external tagging (mainly using the Lea hydrostatic tag) on purse-seine caught fish.

Pre-tagging survey

From 24. July to 3. August five research vessels ("Clupea", "Sir Lancelot", "Michael Siedlecki II", "Willem Beukelsz", and "Jens Væver") completed a hydrographic and echo-survey of the entire area. The combined results are shown in Figure 21. Herring traces were found over a wide area and the tagging ships had little difficulty, at least during the first fortnight, in finding the herring in the localities pointed out by the pre-tagging survey.

Tagging experiment

The Norwegian purse seiner, M/S "Rygrunn", was chartered to provide live material and serve as tagging vessel for the internal taggings. Except for experiment No. 6 all internal tagging was carried out from "Rygrunn", which also provided live material for the external tagging which was carried out exclusively from the two other tagging vessels, "Skagerak" and "Sir Lancelot". The date, position, and number of tags liberated of each type are given in Table 56. Total length was measured on all herring liberated and also scale samples from each externally tagged fish were collected for age determination and L_1 measurements.

The weather conditions were more favourable than in 1957, which is also reflected in the better distribution of tagging positions.

Preliminary results

As expected only a small number of external tags have been returned from the industrial fisheries in 1958. As this part of the experiment is based on the possibility of external tags turning up in the fisheries for adult herring, no results can be expected before the end of 1960.

The internal taggings however, are based on recaptures from the industrial fishery and the results by now are thus not likely to undergo any noteworthy change. Of the 7,901 internally tagged fish a total recovery of 443 or 5.6% was achieved.

In Table 57 the percentage recapture is arranged according to experiment, tagging team, and group. For the latter the fish marked by each team have been divided into 10 groups: — group 1 comprise the first fish marked, group 10 the last, up to five hours after group 1. In the table, groups 1—5 and 6—10 are summarized for all teams in each experiment.

In all liberations the highest percentage of recapture was from team 1. There were also more returns from the fish tagged earlier in each liberation than those for which there was some delay in tagging.

It is reasonable to assume that these differences are due to tagging losses and a minimal estimate of the loss is obtained by assuming that all the first groups of fish tagged by the best team survived. Using the percentages recaptured of these fish, the total effective number liberated was estimated to 4,719.

To estimate the size of the tagged stock the recaptures and statistical data on catch and effort were treated in three sections:—

(1) *The first eight weeks' landings at Esbjerg*

The material was treated by the methods used for the 1957 analysis. That is, the fishing effort by Esbjerg ships was calculated for each 15 mile square for each week. The fishing intensity on the tagged fish was then estimated as the weighted mean of the calculated fishing intensities of four areas of differing sizes surrounding the marking position. The number of tags returned per unit fishing intensity per 1000 fish tagged show a fair agreement between the liberations, and the weighted mean number of returns for the five liberations is 12.14 tags per 100 hours' trawling per square per 1000 tags. This is very close to the 1957 value of 13.56 tags/100 hrs./1000 tags.

During the tagging period (weeks 33—35) the average catch per 100 hrs. fishing of Esbjerg ships was 184 tons. The density of the stock at the time and place of tagging was therefore

$$184 \times \frac{100}{1.214} = 15{,}160 \text{ tons per square.}$$

According to the pre-tagging survey the herring occurrences extended over 50 squares, and the estimated size of the tagged stock is

$$50 \times 15{,}160 = \textit{758,000 tons.}$$

Figure 21. Pre-tagging survey. Bottom temperatures and echo-traces.

Table 56. Survey of released tags

Experiment	Date	Position N	Position E	Internal tag	Lea tag	Bolster tag	Danish tag
I	8/8	56°05′5	-5°36′		681	62	
II	9/8	55°53′5	-6°24′	1,500	743		
III	12/8	55°43′	-5°20′5	1,507	1,162		100
IV	13/8	55°22′	-3°19′		177		
V	22/8	55°49′5	-5°32′	1,094	556		
VI	24/8	54°53′	-3°20′	1,000	701		
VII	25/8	54°36′	-4°14′	2,800	500		
			Total	7,901	4,520	62	100

Table 57. Percentage of tags returned according to tagging team and group of fish (For explanation, see text)

Experiment	Team 1	Team 2	Team 3	Team 4	Groups 1–5	Groups 6–10	Total % returned
II	9.5	—	9.5	4.0	5.3	2.7	8.0
III	11.1	—	2.8	6.7	4.3	2.5	6.8
V	13.2	—	8.1	6.0	4.9	3.4	8.3
VI	—	3.7	4.0	—	2.3	1.6	3.9
VII	4.3	—	3.3	2.2	1.8	1.5	3.2

(2) *German recaptures during the first eight weeks*

The German catch/effort statistics are given in 30 x 30 miles squares and so the method employed for the Danish recaptures could not be used in this case. Instead the fishing effort (number of hauls) in the square in which the fish were liberated, was used for the 8 weeks following liberation. The results are much more variable than those for the Esbjerg fleet. Liberation VI and VII gave usable results and the estimated stock strength is

$$50 \times 11{,}300 = 565{,}000 \text{ tons.}$$

(3) *Danish recaptures after 8 weeks*

The method used in the first section to remove the large differences in the recapture rate from the different liberations could not be used in this case, because of the lack of information on the movement of the tagged fish.

An estimate of the stock size at the time of tagging could however be obtained by the Petersen method plotting numbers of returns each week against the weight of herring landed in the same week. A proportional line fitting these data give 1000 tons = 5.9 tags. From the number of herring effectively tagged the estimated stock size is

$$4719 \times 1000/5.9 = 800{,}000 \text{ tons.}$$

The three estimates of the stock size at tagging agree reasonably well, and as the first probably is the most accurate 750,000 tons is taken as a final estimate.

During the autumn 1958 (weeks 30—50) the total German and Danish catch amounted to 111,200 tons. Accordingly the percentage of the stock present at tagging removed by the fishery is

$$100 \times 111.2/750 = 14.8\%.$$

This estimate cannot be considered significantly different from the estimate of 13% obtained in 1957 and so the experiment of 1958 has given a very useful confirmation not only of the result obtained but also of the methods used in the analysis.

K. Popp Madsen

C. Skagerak, Kattegat, and Baltic-Belt Seas

Danish Herring Investigations in the Skagerak, Kattegat, Belts, and Baltic in 1958

(Tables 58–59)

Larvae of herring

In November 1958 a few hauls with the ring-trawl were carried out in the northern Kattegat. Very great numbers of newly hatched larvae were found north-east of Læsø corresponding with very great catches of herring taken by trawl east of Læsø in October and also in pound nets at the eastern part of Læsø. In one 20 minute haul a record catch of 2,600 herring larvae was taken. Due to the mild winter 1958/59 we may expect that a relatively large number has survived.

Young herring in the Skagerak and northern Kattegat

The herring in three samples from 3. January and in one from 13. January had a mean length of 10.5 cm, and their racial characters prove that they were from the Dogger/Gut region (see basic diagrams in Rapp. Cons. Explor. Mer, **143** (2), 1958). The small length indicates that they had been hatched late in the autumn 1956, i. e., that most likely they were from the Dogger Bank. In many samples from 13. and 28. January and 4. March another herring group of about 13.7 cm length was found, characterized by the same V. S. but lower V.P. and K_2. The length and V.S./V.P. are in accordance with the Shetland-Scotland autumn herring but their K_2 is distinctly lower than in these herring, and it is most likely that they are from spawning grounds in relatively deep water in the north-western North Sea. Their length indicates that they were hatched early in the autumn of 1956. The same group was sampled in June when they had grown to about 16.6 cm. Both groups were found in some samples from 24. March, 6. and 20. May, and 18. June which were not analysed for race.

In three samples from 28. January to 28. March, herring of about 20.8 cm length were found. They were Downs herring.

In June some small herring of about 5 cm length were found in a sample taken in the Skagerak at 66 m depth; they were not analysed for race, but according to length it is certain that they were young spring spawners, hatched in 1958. In some other samples from July and August herring of about 11.2 cm length were present. Their racial characters show that they were Shetland/Scotland autumn spawners, hatched in 1957.

From 7. October to 8. December, herring of about 13.6 cm were found in 6 of the samples analysed. According to their length they must be early autumn spawners, and it may be guessed that they originate

Table 58. Mean length and racial characters of young herring caught in the Skagerak, Kattegat, Belt Sea, and Baltic in 1958

A = Aarhus bay; G = Great Belt; N = north of Fyn; K = east of Kriegers Flak; B = at Bornholm.

	Number of samples	Mean length, cm	V.S. Mean	V.S. Number	V.P. Mean	K_2 Mean	K_2 Number
The Skagerak and northern Kattegat							
3. January	1	10.5	56.47	156	23.88	14.67	90
13. Jan.–4. March	8	13.7	56.49	618	23.58	14.36	683
28. Jan.–28. March	3	20.8	56.64	176	23.93	14.83	173
16.–23. June	2	16.6	56.48	162	23.73	14.30	233
8. August	1	11.2	56.52	108	23.69	14.75	100
7. Oct.–8. Dec.	6	13.6	56.53	278	24.13	14.44	336
1. November	1	15.9	56.43	126	23.73	(14.34)	83
26. November	3	<17.0	56.60	324	23.78	14.97	121
26. November	3	>17.0	56.51	190	23.72	14.50	110
17. December	3	15.8	56.51	72	23.82	—	—
17. December	4	19.6	56.48	111	23.61	14.30	100
The Limfjord							
14. April	1	12.6	56.26	73	23.44	13.98	50
5. September	1	11.2	56.33	43	23.67	(14.48)	48
16. October	1	9.6	55.76	153	23.77	14.38	104
Central and southern Kattegat							
15. October	1	13.9	56.20	111	23.52	14.29	94
13. November	1	12.1	56.15	46	23.70	14.45	53
Northern Belts							
20. Jan.–21. April, A	4	11.9	56.35	418	24.07	14.35	395
20. February, G	1	12.6	56.10	73	24.08	14.28	108
25. August, N	1	8.9	55.75	101	24.55	14.32	104
9.–21. October, A, G	2	13.8	55.88	253	24.24	14.59	170
22. November, G	1	14.2	56.27	100	24.68	14.45	100
3. Nov.–16. Dec., A	4	13.5	56.28	273	23.94	14.26	270
Little Belt							
18. Febr.–17. April	2	14.9	55.98	169	24.46	14.18	225
17. April	1	19.6	55.70	43	23.37	14.04	45
25. Aug.–10. Dec.	3	{10.5 / 13.2}	55.92	455	24.62	14.42	296
Baltic proper							
15. October, K	1	13.4	55.78	131	23.68	14.32	78
28. Jan.–18. March	2	14.4	55.84	210	24.35	14.20	220
8. October	1	17.2	55.30	30	23.57	13.71	28

from the Gut region or nearby grounds although their V.P. is a little higher and their K_2 a little lower than the samples of mature herring known from the Gut. A sample of herring of 15.9 cm length, taken on 1. November had the same racial characters as those in the samples from 13. January to 4. March of about 13.7 cm and in those from 16. to 23. June of 16.6 cm, but their length was too small for this group. Actually they were in a very bad state when received at the laboratory, and it had been noted that the K_2 should possibly be higher than that found, and therefore it is most probable that actually they belonged to the group analysed in the sample from 3. January. The same herring constitute the smaller ones of about 15.8 cm length in samples from 17. December.

In samples from 26. November the smaller ones, of about 15—16 cm length, had racial characters of the Downs herring, and their length corresponds very well to this. We see that the larger ones of about 18—19 cm must belong to the same group as those from 13. January to 4. March and 16.—23. June. They must be mixed with the larger ones of the group dominating in those under 17.0 cm length, and the same race group was found in those of similar length in the samples from 17. December.

Young herring in the Limfjord

In a sample of herring about 12.6 cm in length caught in April in the Thisted broad, the smaller fish were one year-old local spring spawners and the larger ones were North Sea autumn spawners.

A large fishery for small herring was carried out at Thyborøn on the North Sea coast for a few days in September 1958. A small sample of these herring from 5. September (see Table 58) was investigated but they were in a bad state when received, and the K_2 found is undoubtedly too low. Most probably, they belonged to the Shetland-Scotland autumn spawners found in the Skagerak in a sample taken on 8. August.

A sample from October from Hvalpsund were young, Limfjord spring spawners.

Young herring from the central and southern Kattegat and the Belts

Two samples of herring from the central and southern Kattegat, caught in the Isefjord in October and off Mariager fjord in November were coastal spring spawners from the Kattegat or northern Belt Sea, mixed with North Sea autumn spawners (loc. cit.). Their V.S. and K_2 were the same as those of the Kattegat winter spawners, but their V.P. exclude this race.

In four samples from Aarhus bay in the northern Belts from 20. January to 21. April, the herring were mixtures of North Sea autumn spawners and local spring spawners. The North Sea herring were almost unmixed in one sample from 24. March, which had a vertebral count of 56.43 (72), V.P. of 23.96, and K_2 14.64 (84). From the basic diagram (loc. cit.) it is seen that they were Dogger Bank herring. This also agrees with their relatively small mean length. A sample taken from the northern Great Belt on 20. February, consisted of herring 12.6 cm in length which were Kattegat coastal spawners, or perhaps mixtures of North Sea and Belt Sea autumn spawners. In a sample from north of Fyn on 25. August and in two samples from 9. to 21. October, the herring were pure Belt Sea autumn spawners, but in four samples from Aarhus bay taken in the period 3. November to 16. December the herring were Belt Sea or Kattegat autumn spawners mixed with North Sea autumn spawners, or in one of the samples perhaps with Kobbergrund autumn spawners. A sample from the northern Great Belt taken on 22. November 1958 consisted exclusively of Kobbergrund herring.

In the southern Little Belt the herring less than 13.0 cm in length (about 12 cm), sampled between February and April were Belt Sea autumn spawners, but those between 13.0 and 17.0 cm in length (about 15.5 cm) were Kattegat coastal autumn spawners. In a sample taken on 25. August the herring of 9—13 cm length (mean 10.5 cm), and those of 9—17 cm length (mean 13.2) in samples from 11. November and 10. December were Kattegat coastal autumn spawners.

It is seen that young North Sea autumn spawners were encountered in the Belts in rather large numbers throughout 1958, which is unusual. In the first quarter of the year young members of the local spring spawners were found in most of the samples, but in the summer and autumn the young of Kattegat and Belt Sea coastal spawners were predominant. We may expect that the autumn fishery of herring for human consumption will continue to improve in the coming years.

Young herring in the Baltic

A sample of herring about 13.4 cm long taken on 15. October between Møen and Arkona to the east of Kriegers Flak were young spring spawners; the high K_2 indicates that they were possibly not from the Baltic but from the Kattegat (see Rapp. Cons. Explor Mer, **143**). The herring at Bornholm, west of Rønne, in two samples from January and March, were $1^1/_2$ years old and were Kattegat coastal autumn spawners, only to a very small degree mixed with the young more southerly herring, presumably from the Baltic.

In 1957 a very strong inflow from the Kattegat to the Belts and the Baltic took place. In the Belts it was followed by the appearance of young herring from the northern Kattegat and the North Sea, and also by the very unusual occurrence there of young, Skagerak/northern Kattegat sprat, and in the Baltic by young Belt Sea sprat (see Ann. Biol., **14**: 202).

In October 1958 a small sample of young herring from west of Bornholm had the racial characters, as found previously by Heincke and Hessle, of spring spawning herring in the central Baltic.

Herring fished for human consumption

With the kind help of the Fiskeridirektoratets Havforskningsinstitutt in Bergen (Norway) a sample of herring was taken from the north of Bergen in March 1958; the racial analysis of this sample is given in Table 59. It is seen that the values for V.P. and K_2 are the same as those in the few previous samples (see Rapp. Cons. Explor. Mer, **143**) where also these characters are known. Most of the herring were 6-ringed, belonging to the 1951 year-class.

About half of a sample caught west of Lindesnes on 14. April were immature with a V.S. of 56.81. Their racial characters were almost the same as the large winter spawning herring of the northern Kattegat. Most of them were 2-, 3-, and 4-ringers and were about 27 cm in length. The remainder were spents and recovering spents and were a little larger. Most of them had 4—7 rings. The racial characters show that they were mixtures of the Norwegian large winter spawning herring and North Sea autumn spawners. Their V.S. was 56.65.

Table 59. Racial characters of herring caught for human consumption in the North Sea, Skagerak, Kattegat, Belt Sea and Baltic in 1958

D = drift-net; Pn = pound net; Ps = purse seine; T = trawl.

Locality	Date	Gear	Maturity	Length, cm Mean	Length, cm Range	Winter rings	V.S. Mean	V.S. Number	V.P. Mean	K_2 Mean	K_2 Number
W coast Norway ...	2/3	Ps	IV–VIII	32.8	29–38	3–13	57.08	171	24.34	14.01	172
NNW of the Scaw ..	24/3	T	I–II–III	21.1	16–25	0–3	56.62	141	23.91	14.78	138
			—	26.1	24–29	1–6	56.26	57	24.02	14.36	55
			V	26.3	23–29	2–5	56.0	15	23.5	14.4	15
			VII–VIII	28.3	25–32	2–13	56.48	94	23.97	14.45	93
Off Egersund	2/11	T	I–VIII	28.6	21–34	1–13	56.71	231	23.80	14.48	225
E and N of Læsø....	29/10–4/11	T, Pn	I–III	22.6	19–28	1–5	56.20	94	24.21	14.16	92
			IV–VII	24.7	19–31	1–12	56.17	252	24.57	14.40	257
SW Kattegat	14/10	D	V–VIII	27.7	21–31	1–11	55.99	102	24.94	14.36	101
Isefjord	1, 10, 15/4	T	I–III	21.6	18–25	1–4	55.82	60	23.80	13.74	58
			IV–VII	24.9	18–34	1–8	55.88	277	23.52	14.03	271
N Great Belt	9/10	T	I–III	22.6	19–26	1–4	55.90	40	23.80	13.98	41
			IV–VIII	23.0	19–30	1–5	55.78	60	24.50	14.56	61
N of Langeland	6/10	D	V–VII	26.3	23–30	2–5	55.72	60	24.85	14.30	60
S of Møen	15/9	D	I–II	21.9	18–25	1–3	55.60	123	24.19	—	—
			III–VI	23.2	18–26	1–4	55.49	115	24.37	—	—

Racial investigation of a sample of herring caught on 24. March in the open Skagerak shows that the immature fish, which constituted about 40% of the total number, were Downs herring of about 21 cm length, but that some of them most probably were coastal autumn spawners from the Kattegat, mixed with North Sea autumn spawners. The spents and recovering spents were about 28 cm in length and had 3—6 winter-rings.

East of Læsø, and partly also in pound nets at the eastern part of Læsø, a large herring fishery was carried out in the autumn. Most of these herring were about 25 cm in length and were full or just spent. They were Kattegat autumn spawning coastal herring, and most of them had 3—5 rings. Immature herring about 23 cm and mostly 2-ringers had about the same vertebral count but their K_2 range them among the spring spawners. Most likely they were mainly Kattegat coastal spring spawners but mixed to a small extent with North Sea autumn spawners.

The spring spawners of the southern Kattegat were investigated in catches from the Isefjord in April. Their racial characters were usual for these local coastal spring spawners from the southern Kattegat and northern Belt Sea. About 20% of the number caught were immature 2-ringers, but the greater part were mature fish of which more than 33% also had 2 rings (1955 year-class). The 1953 year-class (4-ringers) was relatively numerous, corresponding to the fact that this year-class was predominant in the catches in 1957.

In October, a sample of herring in the southwestern Kattegat, at the entrance to the Belts (Hastens Ground) was about 28 cm long and consisted of mature herring just before spawning. They were Kattegat large coastal autumn spawners, the same tribe as those found at Læsø, but here the 3-ringed fish were dominant. In the Great Belt, north of Sprogø the same mature herring, but younger, were encountered in October, but immature spring spawners of almost the same length constituted nearly half of the catch. A little more to the south, N of Langeland, a sample consisted exclusively of autumn spawners of the same stock but a little larger and of the same age composition as at Hastens Ground.

In the Baltic proper, south of Møen a large autumn herring fishery was carried out. The herring in a sample taken in September were Sound autumn spawners with 1—3 rings.

Aage J. C. Jensen

Polish Investigations of Herring in 1958

(Table 60)

The age and length composition of spring spawners on the fishing grounds of the southern Baltic during the summer/autumn feeding period are presented in Table 60.

These herring, belonging to the central Baltic stock contributed last year about 60% of the total Polish catches of Baltic herring.

The most numerous year-classes in both areas were those of 1949, 1952, 1953, and 1954.

The catch per day fishing (according to H. Janko) in the summer/autumn season, when this stock of herring predominated in the landings is presented below.

Table 60. Length and age distribution of Baltic herring (‰)

Length

cm	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Number invest.
Gdansk Region	1	7	13	8	47	117	155	157	126	127	98	83	39	13	6	2	1	6,656
Bornholm Basin	—	—	—	5	21	64	153	157	158	150	130	96	51	12	2	1	—	3,288

Age

Years	2	3	4	5	6	7	8	9	10	11	12+	
Year-classes	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948		Nos.
Gdansk Region	21	42	99	150	136	113	68	94	137	86	54	600
Bornholm Basin	10	19	100	163	158	126	75	104	120	75	50	700

Table 61.

Year	Gdansk Bay kg/fishing day	Bornholm Basin kg/fishing day
1955	200	944
1956	478	786
1957	85	688
1958	243	621

As in 1957 the local stocks of spring herring spawning in the brackish water of the Gdansk and Pomeranian Bays gave very low catches during the spawning season in spring. The landing of autumn spawners especially in the Bornholm Basin increased greatly. The very good year-classes of 1952 and 1954 predominated in the catches.

In general the catches in the southern Baltic were much better than in 1957.

The quality of the herring was rather poor. The length-weight coefficient (maturity stages II—III) decreased in Gdansk Bay from 0.696 in 1957 to 0.624 in 1958 and in the Bornholm Basin from 0.712 in 1957 to 0.657 in 1958.

J. Popiel, J. Elwertowski

Sardine

Sardine

Pêche de la Sardine dans la Région de La Rochelle

La saison de pêche a débuté en mai par la capture de sardines du Gr. I, de taille modale et de moyenne vertébrale élevée (145 mm / 52,32).

En juin elles sont remplacées par un second Gr. I, de taille modale, moyenne vertébrale et taille à L_1 plus faibles (130 mm / 52,21 / 90 mm).

Au début de juillet on retrouve toujours ce poisson, mais plus grand (150 mm) et il disparait bientôt des lieux de pêche pour y être remplacé par des individus du Gr. 0, à moyenne vertébrale de 52,22 et de petite taille modale (100 mm).

Toutes ces sardines appartiennent au type armoricain et forment une population toujours présente sur les pêcheries jusqu'au début de l'été. A cette époque elles disparaissent, à l'exception toutefois du Gr. 0 auquel vient s'ajouter un Gr. I de type aquitanien et qui, à eux deux, constituent la population d'été et d'automne des années normales.

Or cette année il semble bien que le Gr. 0 armoricain n'a fait sur nos côtes qu'une brève incursion en juillet et que le Gr. I aquitanien n'y soit apparu qu'à partir de la mi-septembre, en très faible quantité, et mélangé avec des individus du Gr. II, donnant ainsi une population de taille modale 175 mm et de moyenne vertébrale 52,04.

En octobre ce peuplement a été à son tour remplacé par un troisième, de type cantabrique cette fois, formé des Gr. 0 et I (130 et 155 mm) et caractérisé par une moyenne vertébrale de 51,91—51,95.

Cette situation a coïncidé avec de mauvaises pêches d'été.

R. Letaconnoux

Sprat

Tagging Experiments on Sprat in Norwegian Waters

In connexion with the routine investigations on sprat tagging experiments were carried out during 1958 for the first time in Norway.

The tags used were of thin red plastic of the same shape as the Norwegian internal herring tags. The tags were fastened dorsally by nylon.

To keep the sprats untouched by hand and in water during tagging, the "tagging sluice" (Aasen, 1953; see Ann. Biol., **10** : 148) were modified for use on sprats.

At first some control experiments were made with the same number of tagged and untagged fish. When the sprat were in good condition before tagging the mortality seemed to be just the same for tagged as for untagged fish.

In the middle of July 211 tagged sprat were liberated at Norheimsund in the Hardangerfjord. At the end of August two of these fish were recaptured nearly at the same spot where they had been liberated. The recaptured fish showed a little wound around the fastening place of the tag. This arose suspicion that the tag could swell out and fall off.

In order to investigate this about 600 sprat were tagged with different types of tag and various dimension of the nylon-gut. All these sprat were kept in captivity in a live net for more than a month. A later investigation of the wounds showed that the smallets tag and the thinnest nylon-gut gave the best result.

On 5. September 212 sprats were tagged and liberated at the above mentioned place. In mid-October one of these fish was recaptured in Simadal in the Eidfjord, the distance between the tagging and recapture place being about 28 nautical miles. This is the first recapture of migrating sprat.

Kaare R. Gundersen

Danish Catches of Sprat from the North Sea, Skagerak, and Kattegat

(Tables 1–2)

Eggs and larvae

Fishing for eggs and larvae of sprat was carried out in Skagerak and the northern Kattegat in June from "Havkatten" and "Biologen" with the Hensen net, and with 1 and 2 m ring-trawls, but as yet only part of the samples has been analysed. The impression is that eggs and larvae of sprat were very scarce in 1958.

Length distribution, age, and abundance

In the industrial herring fishery in the Bløden Ground area some few per cent. by weight of some of the catches consist of sprat. These sprat were investigated from 3 catches made in February,

Table 1. Length composition (%) of sprat in the different quarters of 1958
(Total length to centimetre below)

	SE Skagerak–N Kattegat						Limfjord		Isefjord
	1st quarter		2nd quarter		4th quarter		2nd quarter	4th quarter	4th quarter
Depth, m	33—45	79—150	30	78—97	24—48	60—113	18	20	10
Length, cm									
6	6	—	—	—	—	—	—	1	—
7	9	1	—	—	4	2	—	14	—
8	9	9	—	2	8	—	—	86	—
9	15	22	9	9	25	—	4	—	—
10	12	18	13	5	32	—	51	—	—
11	9	2	6	7	5	—	35	—	—
12	15	7	11	7	16	8	9	—	6
13	18	12	22	7	8	26	1	—	40
14	—	16	19	26	1	14	—	—	40
15	3	10	19	24	—	18	—	—	12
16	3	3	2	11	—	33	—	—	1
17	3	—	—	2	—	—	—	—	—
Total	102	100	101	100	99	101	100	101	99
No. invest.	34	129	236	55	75	51	565	308	148
No. of samples	8	8	1	6	4	7	1	1	1

July, and October respectively. The length range was from 10 to 14 cm. Most of them were 2 to 3 years old. From the R/V "Dana" sprat were caught in November, some 17 miles west of Horns Reef in water 32 m deep, and also in the outer section of the German Bight, some 70 miles SW of Esbjerg in water of 37 m depth. These sprat were about 12—15 cm long, and predominantly $4^1/_2$ years old. Four of the North Sea samples and that from NNW of Hirtshals have been placed at my disposal by Mr. Popp Madsen.

In the Limfjord the sprat in a sample taken in April were about 11 cm long, and 2 years old, and in an October sample about 8 cm long, and $^1/_2$ year old. They constituted 26% and 17% by weight of the catches, which is about the normal relative frequency in this area.

The length distribution of sprat caught commercially in the Skagerak, Kattegat, Belts and Baltic by trawls with cod-end meshes of 11—18 mm is given in Table 1. In Skagerak and northern Kattegat only a small number of sprat was caught in trawls with 18 mm meshes. This mesh size is used exclusively for herring and for Norwegian prawn in this area, and nearly all the small sprats escape through the meshes, if present on the fishing grounds. Therefore the length distributions for these areas are only given for nets with 11—16 mm meshes used for fishing small herring.

In Skagerak and northern Kattegat the sprat is usually larger in catches made outside the 60 m line than in shallower water. In the first quarter of the year few sprats only were found in the samples analysed, and little value can be attached to their length distribution. It seems that approximately half of these sprats was about 10.0 cm long, which is in between the normal mean length for the $^3/_4$ and for the $1^3/_4$ year-old sprats, and it may safely be assumed that they did belong to the I-group, but that their growth had been very poor (see Ann. Biol., **13**, Fig. 7, p. 227). The other half was predominantly 13—$14^1/_2$ cm long, and age determinations from scales and otoliths reveal that most of these were $3^3/_4$ and $4^3/_4$ years old. In the second quarter of the year the smallest of these length groups was rather scarce. In the fourth quarter of the year the length distributions were rather similar to those in the first quarter, comprising a group of about 10 cm length (i.e., $1^1/_2$ year-old but again rather small for their age) and a group of 13—17 cm long. As in previous years sprat were relatively scarce in the average catches in the first quarter of the year; from 33—45 m depth and 79—150 m depth respectively, about 1% and 3% by weight of the catch were sold to fish meal factories. In the second quarter of the year about 5% were sold in this way, and in the fourth quarter about 5—6%. In a few catches from depths over 75 m sprats were caught in larger quantities, so that 10—30% of the total weight consisted of sprat, which were sorted from the catch and sold for human consumption. Sprat in a sample caught by the R/V "Dana" in November, NNW of Hirtshals in water of 55—71 m depth were very large, 15—18 cm long, and predominantly $8^1/_2$—$9^1/_2$ years old.

From the Isefjord in the southern Kattegat a sample taken in October has been analysed. These sprats were large, 13—16 cm long, but constituted only 0.6% by weight of the catch.

Table 2. Racial characters of sprat from the North Sea, Skagerak, and Kattegat in 1958
(In brackets number examined)

	Month	Number of samples	Length, cm	V.S.	K_2
SE North Sea	February	1	10—12	47.92 (39)	11.71 (48)
	July	1	11—13	47.48 (63)	11.48 (63)
	October	1	10—13	47.70 (79)	— —
	November	1	12—14	47.64 (77)	11.78 (85)
	November	1	11—14	47.67 (130)	11.73 (134)
Skagerak and N Kattegat	Jan./May	3	11—16	48.20 (51)	11.87 (52)
	Nov./Dec.	5	7—16	48.06 (109)	11.68 (92)
Skagerak NNW of Hirtshals	November	1	15—18	48.07 (115)	11.79 (116)
Limfjord	Apr./Oct.	2	7—12	47.40 (237)	11.42 (292)

Racial characters

The samples from the North Sea supplement our knowledge of the racial characters of the local sprat stock in a very welcome way. From Table 2 can be derived that only one of these samples, viz., that collected in February on the Bløden Ground in water of 40 m depth, reveals the same racial characters as those from the Danish catches in the Skagerak. We surmise that eggs and larvae of sprat are carried from the North Sea into the Skagerak, but thus far we had only knowledge of two North Sea samples with the same V.S. as the Danish Skagerak sprats (their K_2 is not known). One of these samples came from St. Andrews Bay, not a very likely place for transport to the Skagerak. Four other 1958 samples, from the same region between Dogger Bank, Horns Reef, and the German Bight, had a distinctly lower V.S., and one also a lower K_2, than those from that section of Skagerak where the Danish fishery is carried out. They had, however, the same V.S. as some of the sprat from the Norwegian coast. The newly collected North Sea samples confirm the conclusion drawn from the investigations in previous years: "the sprat stock at the Norwegian coast is to a far higher degree recruited from the stock in the North Sea than from the stock in that part of the Skagerak where the Danish fishery is carried out".

The racial characteristics of the sprat samples from Skagerak and northern Kattegat reveal a slightly higher V.S. than was found here in previous years; this is especially so in the samples collected in the period January—May. Some very large sprat caught by the R/V "Dana" NNW of Hirtshals in water of 55—71 m depth showed the same characteristics as those from the Skagen-Frederikshavn region.

Two samples from the Limfjord revealed the same racial characters as samples previously collected here and as two samples from the Horns Reef region.

In the central Kattegat off Mariager fjord sprat of about 7—10 cm in length caught in November by the R/V "Biologen" revealed the same V.S. and K_2 as a commercial catch of sprat of 12—15 cm in length made in October in the Isefjord. Table 2 reveals that the racial characteristics of these sprat were the same as found in many samples from the Belts, but that they were decidedly different from those of the Skagerak sprat.

Aa. J. C. Jensen

Danish Investigations on Sprat in the Belts and the Baltic Proper

(Tables 3–4)

In the northern Belts and the southern Great Belt the 1957 year-class constituted the major part of the commercial catches in 1958. As normally they were about 8 cm long in the 1st quarter of the year and about 10 cm in the 4th quarter. In two samples taken during the first six months of the year in the southern Little Belt most of the sprat were 2 and 4 year-olds, on the other hand the 1957 year-class dominated in 2 samples from the 4th quarter of the year. In some of the samples from the Belts a small part of large sprat were sorted from the catches investigated and the relative frequency of the larger sprat and the older age-groups is therefore a little under-represented in Table 3. In the northern Belts the sprat constituted in the first six months of the year on an average 7% of the catches investigated, but in the 4th quarter about 25% of the catches. In the Little Belt was found a similar increase of the relative proportion of sprat.

From the Møen region the sprat in a catch in October were 13—14 cm long and constituted 18% by weight of the catch.

At Bornholm the sprat in a sample from January were mostly of the 1957 year-class and in two

Table 3. Length composition (%) of Belt Sea and Baltic sprat in the different quarters of 1958

(Total length to centimetre below)

	Northern Belt Sea			S Great Belt	S Little Belt		At Møen	At Bornholm		
	1st quart.	2nd quart.	4th quart.	4th quart.	1st/2nd quart.	4th quart.	4th quart.	1st quart.	2nd quart.	4th quart.
Depth, m	10—36	14—36	13—55	15	34	30—34	44	35—45	40	40—50
Length, cm										
4	—	—	0.1	—	—	—	—	—	—	—
5	3	2	3	2	—	—	—	—	—	—
6	18	9	8	9	2	—	—	—	—	—
7	25	12	6	29	4	2	—	16	—	—
8	19	21	17	41	15	31	—	54	0.5	0.3
9	18	17	37	15	29	43	—	16	1	0.6
10	6	5	22	0.4	11	22	—	0.7	4	22
11	2	4	5	0.8	4	0.4	—	5	34	29
12	5	12	0.7	0.8	14	0.5	22	8	53	37
13	4	14	0.7	0.8	20	0.9	72	1	7	10
14	0.3	4	2	—	2	0.3	6	0.4	0.2	2
15	—	—	—	—	—	0.1	—	—	—	—
Total	100	100	101	100	101	100	100	101	100	99
Number invest.	377	137	1379	241	55	1067	54	540	415	387
Number of samples	6	3	6	1	2	2	1	2	1	1

Table 4. Racial characters of sprat from the Belt Sea and the Baltic in 1958

	Month	Number of samples	Length cm	V.S.	K_2
Northern Belts	March/Dec.	9	7—14	47.82 (628)	11.52 (568)
S Great Belt	October	1	11—14	47.81 (109)	11.50 (105)
S Little Belt	April/Dec.	3	7—15	47.92 (309)	11.55 (164)
At Møen	October	1	11—14	47.70 (50)	11.15 (53)
At Bornholm	Jan./Oct.	4	7—13	47.81 (395)	11.33 (383)

samples from August and October of the 1956 year-class. Here they constituted in the first sample 44% of the catch, in the two others 94% and 75% by weight.

The samples in the northern Belts and the southern Great Belt show racial characters normal for this region. In 1957 the high V.S. and K_2 in about half of the samples and the high yearly mean values of these characters indicated a mixture of local sprat and sprat inborne from the Skagerak — northern Kattegat. In 1958 the V.S. was at the higher limit for those indigenous in the Belts but the low K_2 indicates that the sprat in 1958 really were of the Belt-race. In the southern Little Belt the racial characters were nearly the same.

At Møen the V.S. was the same as in the Belts but the very low K_2 indicates a special race; the V.S. and K_2 were nearly the same as in a sample from east of Bornholm in 1957. At Bornholm the V.S. and K_2 in four samples were intermediate between that of the Møen sample and values found by Hessle on the Baltic coasts of Sweden and in the central Baltic.

Aage J. C. Jensen

Polish Investigations on Sprat from the Southern Part of the Central Baltic – 1958

(Table 5)

In 1958 the number of sprat investigated was as follows:—

Area	Number of samples	Number of sprat measured	Number of sprat aged
Bay of Gdańsk	34	12,446	1,259
Bornholm Area southern part	12	6,455	662
Total	46	18,901	1,921

Moreover the fat content was determined in 56 samples.

In the particular seasons of 1958, the changes observed in the age composition of the sprat catches are shown in Table 5.

In both areas the main part of the sprat catches obtained in winter and in spring — summer, consisted of the 1955 year-class. This year-class can be considered to be very rich. In autumn, in the Bay of Gdansk the frequency of the 1955 year-class decreased strongly.

The participation of the 1957 year-class increased simultaneously. These changes can be as-

Table 5.

A. Bay of Gdansk

Brood Year-class	Winter	Spring—Summer	Autumn
	frequency in ‰		
1958	—	—	18
1957	316	175	552
1956	18	31	42
1955	601	780	343
1954	48	12	40
1953	13	2	2
1952	4	—	—
Total	1,000	1,000	1,000

B. Bornholm Area — southern part

1958	—	—	4
1957	45	85	142
1956	24	—	30
1955	812	720	753
1954	92	47	66
1953	26	35	5
1952	1	13	—
Total	1,000	1,000	1,000

cribed to the natural processes of mortality and of recruitment.

It is interesting that the above phenomena were not observed in the Bornholm area.

The frequency of the 1956 year-class in the catches was low — this year-class is very poor in the Bay of Gdansk and in the Bornholm area as well.

The length increment (t) of the sprat caught in the Bay of Gdansk was in 1958:—

t_1 — 8.7 cm (data calculated from fish recruited into adult stock only)

t_2 — 2.6 cm t_4 — 0.5 cm

t_3 — 0.7 cm t_5 — 0.2 cm

In the autumn of 1958 the maximum content of fat observed was 16.2%; the mean water temperature during the feeding period (August—October) was 15.6°C.

In comparison with 1957, the rate of growth and the content of fat of the sprat in 1958 were lower, in spite of the water temperature, which in 1958 was higher than in 1957. The strong rate of growth and high content of fat in the sprat in 1957 can probably be ascribed to the recovery processes which occurred in 1957 in the organism of the sprat after the very unfavourable conditions in 1956.

JAN ELWERTOWSKI

Scombriform Fish

Mackerel

German Investigations in the North Sea

(Figures 1–2)

In October 1957 and 1958, length measurements of mackerel caught by herring trawl were carried out during the cruises of F.R.S. "Anton Dohrn" in the North Sea. The results are given in Figure 1 showing great variations in the length distribution from year to year. From February/March 1956, the 1955 year-class can be followed as a separate and prominent peak in the length curves. At the beginning of 1956 this year-class was only poorly represented in the northern North Sea as 0-group, 15—18 cm in length, it grew, however, to 23 cm in average length predominating as I-group fish in the catches taken in October 1956 in the central North Sea. One year later, in September/October 1957, the 1955 year-class (II-group) forms a peak at 27 cm in the length curve, progressing to 31 cm (III-group) in October of the following year after having spawned. The average lengths of the age-groups correspond very well with the results obtained by examination of the otoliths (see Ann. Biol., **14**: 206).

The growth of the 1955 year-class becomes evident in the length curves of October 1956—58 especially as the neighbouring year-classes of 1954 and 1956 are very scarcely represented. In February/March 1956 a wide gap separates the 0-group from the II-group indicating the absence of the I-group (1954 year-class). In the catches of October 1956 from the central North Sea and the Dogger Bank area, the 0-group (1956 year-class) is completely missing. Accordingly, in the autumn of 1957 a wide gap exists between the II-group and the 0-group from which 180 fish have been caught. The length distribution in 1958 shows that the 1957 year-class was also very poor, as age-group I was very rare. In the catches of October 1958 the 0-group (1958 year-class) dominated at 89% and an average length of 13.8 cm. A wide gap caused by the poor 1956 and 1957 year-classes, separates the 0-group from older fish.

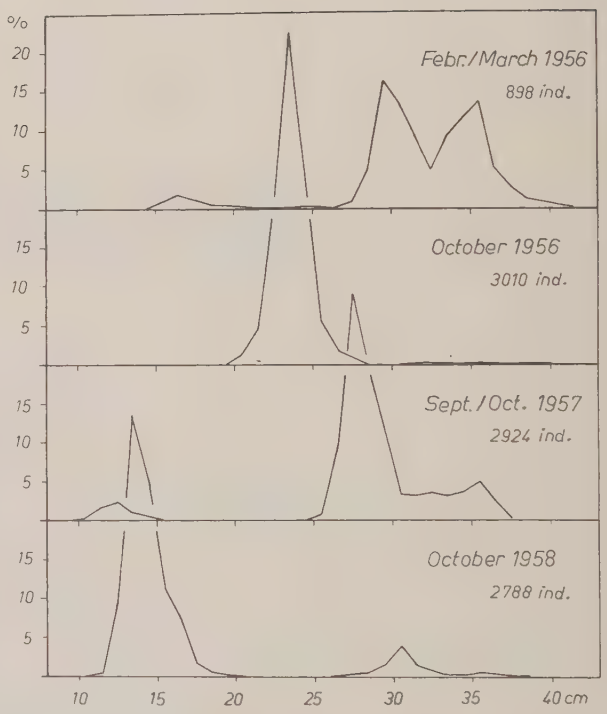

Figure 1. Length distribution of mackerel in catches taken in the North Sea by F.R.S. "Anton Dohrn" in 1956/1958.

So many 0-group mackerel have never been caught in the open North Sea before, places of capture in October 1958 are therefore given in Figure 2. The greater part was obtained on the southern Dogger Bank, the largest catch, 1348 fish in 30 minutes trawling, at the south-western edge at 41—44 m depth (23. Oct. 1958, 54°24′N, 01°36′E). In the preceding year the best catch of 0-group

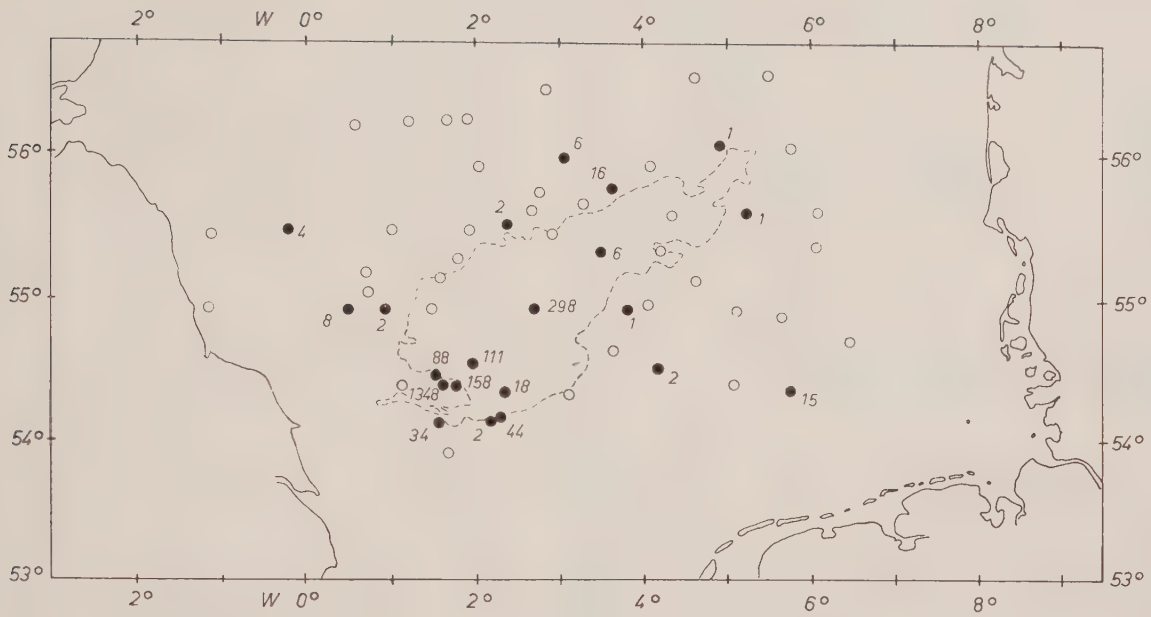

Figure 2. Catches of 0-group mackerel (the 1958 year-class) taken in herring trawl in 30 minutes trawling by F.R.S. "Anton Dohrn" in October 1958.

mackerel (157 fish) was made at the north-western edge of the Dogger Bank (29. 9. 1957, 55°10′N, 01°27′E, 42 m).

Although one must be cautious in drawing general conclusions from trawl catches of pelagic fish, the results obtained in 1956—58 suggest very strong fluctuations of the stock of mackerel in the North Sea. This necessitates further investigations as to the extent and causes of these fluctuations.

R. Kändler

Mackerel Fishery in the Netherlands in 1958

(Figures 3–5; Table 1)

Information concerning catch, area of fishing, and numbers of fishing hours has been collected by the same methods as those applied in studying the Netherlands herring trawl fishery (see Ann. Biol., **14**: 175).

In August 1958, a regular system of market sampling was commenced, together with market measurements in order to obtain information on the age composition of the catch taken in the different fishing areas.

Age determination is based on otolith reading which appeared to be the best method for mackerel. One hyaline winter-ring enclosed by two opaque zones is counted for each year. As «birthday» date of the mackerel the first of April has been chosen.

For practical reasons the North Sea has been subdivided into four fishing areas, viz., NN, NE, NW, and S as shown in Figure 3. In Table 1 the catch per area for a period of three months is presented. The total catch for 1958 amounted to 12,661.5 tons, slightly less than in 1957 (13,100 tons). The most profitable area was NE, yielding a total of 6,854.4 tons, with peak values in spring and autumn. In the southern area the catch was highest in summer (515.9 tons), but the total output was rather modest here.

Table 1. Total catch of mackerel taken per area in three-month periods in 1958 (tons)

	N	NE	NW	S	Total
January/March	766.6	383.2	3.7	—	1,153.3
April/June	868.4	3,353.5	404.1	100.8	4,726.6
July/September	749.0	173.4	1,414.1	515.9	2,852.2
October/December	831.2	2,944.5	30.1	123.5	3,929.3
Total	3,215.1	6,854.4	1,851.8	740.2	12,661.5

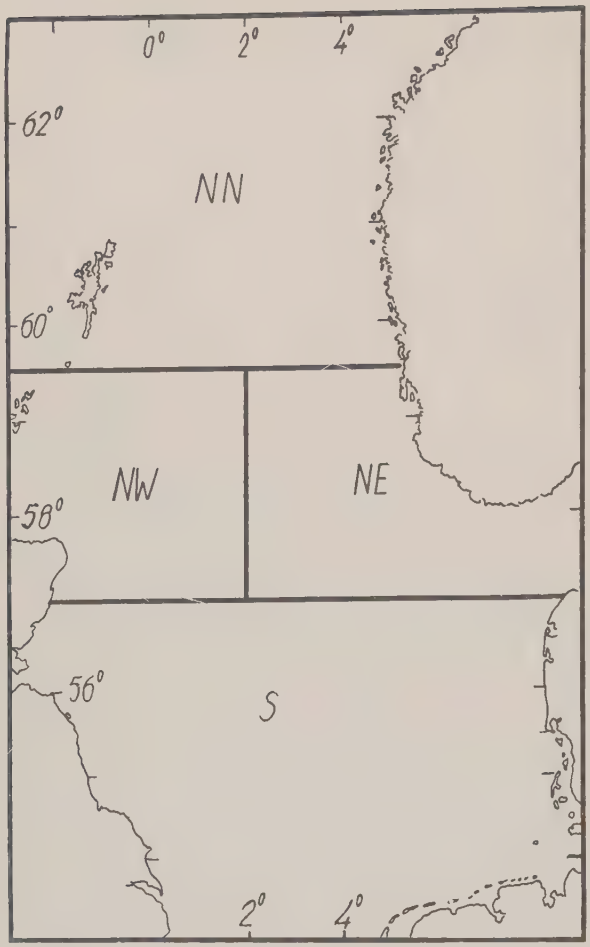

Figure 3. The areas of fishing

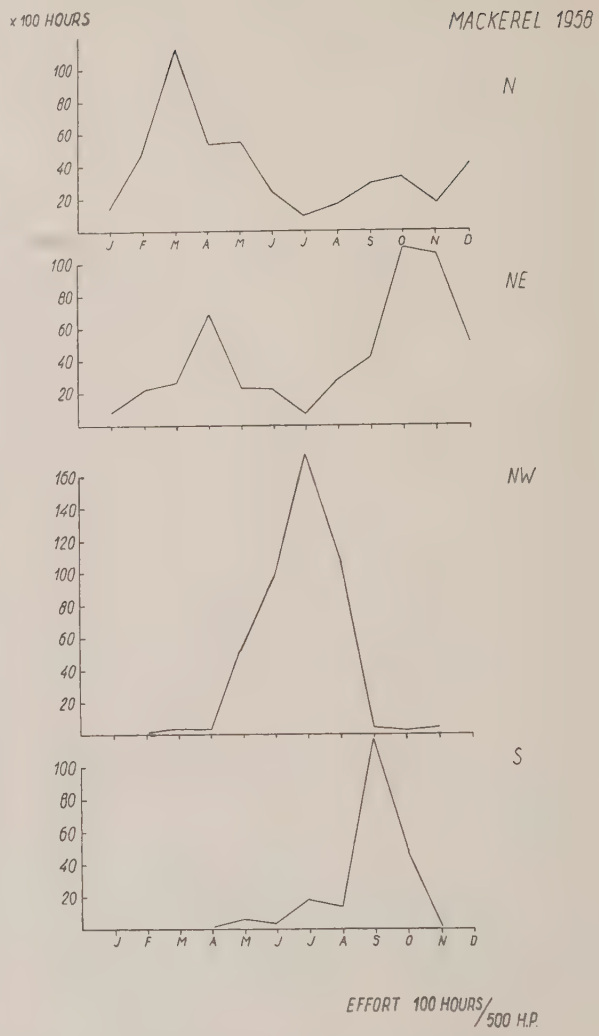

Figure 4. Fishing effort per area throughout the year expressed in 100 hours' fishing of a standard motor trawler of 500 h.p.

Figures 4 and 5 show the catch per effort and the effort for each month expressed per area.

The effort figures are identical for the herring and the mackerel fishery since both species are caught together in the so-called mixed fisheries and the herring-trawl fishery.

The fishing intensity was very low in January and February but increased rapidly in March since good herring concentrations were then found in the northern area. In the course of the year the fishery shifted from N to NE in April, to NW in June where it remained during July and August, then in August towards the south (Dogger Bank — East Bank — Farn Deep), to return to the areas NE and N in October.

The fishery in the NW area, carried out in June, July, and August and also that in the southern area in September is predominantly a fishery for herring.

The figures for the catch per unit of effort show two periods of good mackerel fishery, the first in April and the second in August/September. In the southern area the period from May to July seems to be the most abundant.

Age composition

Sufficient age-composition data are available for comparison of the areas N and NE; for the areas NW and S only data for August are available. No age determinations were carried out in September.

In the north the older year-classes were predominant, except in November. In the NE area the picture is another one, the younger year-classes

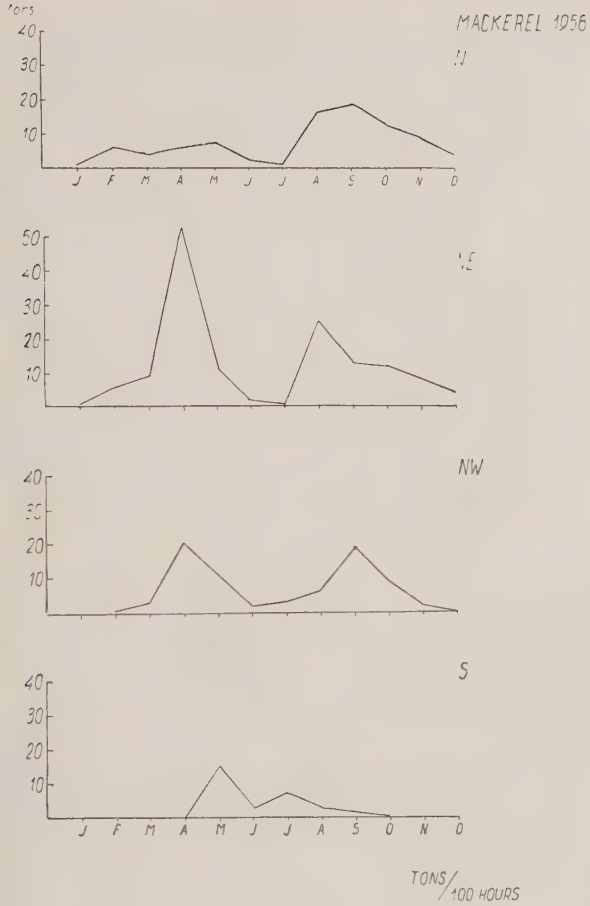

Figure 5. The catch in tons per 100 hours' fishing of a standard motor trawler of 500 h.p. taken in the four areas during 1958.

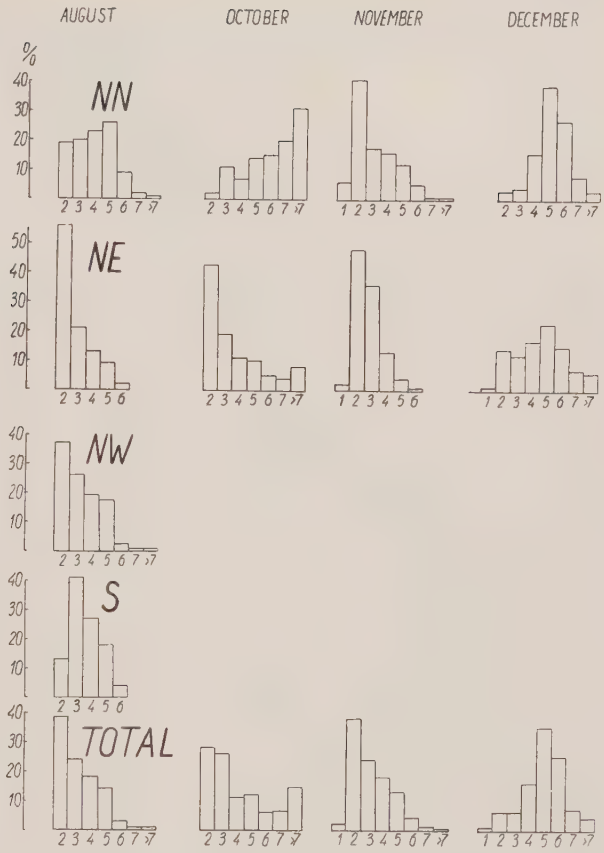

Figure 5. Age composition (winter-rings) of mackerel in the four areas considered during August and October/December. No data are available for September.

being predominant there, except in December when older mackerels were more plentiful. At the time of the second peak in the catches, in August, September, and October, the two and three year-old fish predominated, constituting about 70% of the total catch in the NE area, but only 30% in the northern area. In August, the two year-old fish are absent in the southern area. On the other hand, the age composition of the NW area appeared to be quite normal.

J. Beukema,
J. J. Zijlstra,
K. H. Postuma

Tuna

Tuna Investigation in Norwegian Coastal Waters 1954—1958

(Figures 6–9; Tables 2–15)

Among the great number of tuna species, only the bluefin tuna (*Thunnus thynnus* L.) is common in Norwegian waters. On its feeding migration, following the spawning, the tuna appear along the whole Norwegian coast during the summer months. Up to 1920, Norwegian fishermen caught tuna with angling gear and hand harpoon, but these fishing gears gave a rather poor yield. It was, however, realized that the tuna in Norwegian waters was poorly exploited and in the late 1920's intensive experiments were launched to construct a purse seine strong enough to hold this giant fish, and at the same time manageable for fishing operations. It should take about twenty years to work out the problems, but the successful result obtained in

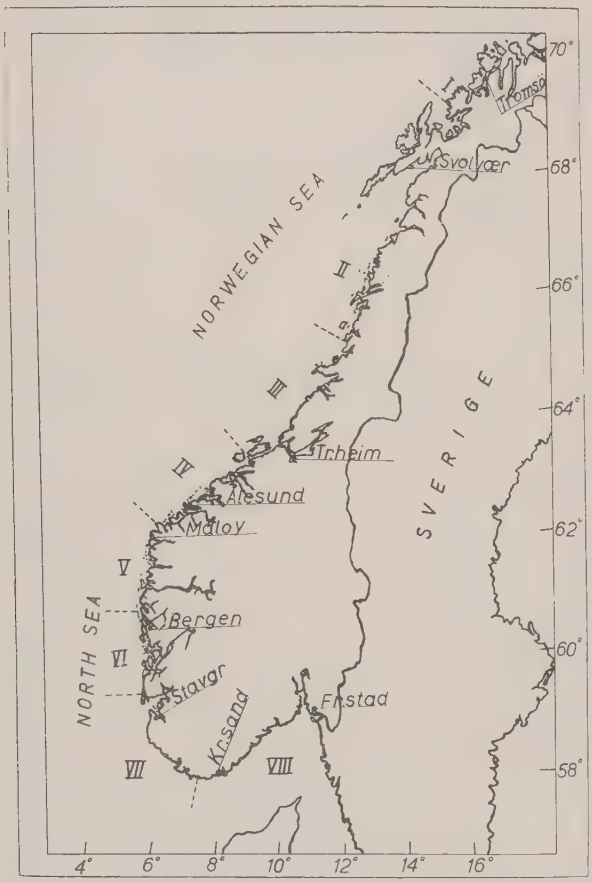

Figure 6. The districts of the Norwegian tuna fishing grounds.

the late 1940's caused a rapid expansion of the Norwegian tuna fishery. Thus in the years 1946—50 the yearly mean catch of tuna in Norway was 1,016 tons, whereas the yearly mean in 1951—55 increased to 8,908 tons.

The Norwegian tuna investigations at the Directorate of Fisheries, Institute of Marine Research, started in 1954 and since no contribution to *Annales Biologiques* has been given earlier, the material collected in the years 1954—58 will be included in this year's contribution.

I. Length, weight, and age

(a) The Norwegian fishermen have their own sales organizations which deal with all tuna landed in the country. These are, from North to South (see Fig. 6): Norges Råfisklag, with branch offices in Tromsø (I), Svolvær (II), and Trondheim (III). Sunnmøre og Romsdal Fiskesalslag, Aalesund (IV), Sogn og Fjordane Fiskesalslag, Målöy (V), Hordaland Fiskesalslag, Bergen (VI), Rogaland Fiskesalslag, Stavanger (VII), Skagerakfisk S/L, Kristiansand S., and Fjordfisk S/L, Fredrikstad (VIII). The boundaries of the different districts are entered in Figure 6 (dotted lines). The tuna fishery is carried out essentially in the open sea, from the coast to ca. 50 nautical miles off. It may, however, happen that catches taken near the borders are landed in adjacent districts. On the basis of catch statistics obtained from the sales organization the commercial mean weight of tuna ($\overline{w'}$) landed in the districts is calculated (Table 2). The commercial weight is the weight of gutted fish. On the basis of 49 corresponding measurements of gutted (w') and ungutted (w) tuna, the correlation coefficient $r_{(w,w')}$ is calculated giving a value of 0.999, and the regression equation between the measurements is:

$$w = 1{,}285\ w' + 0.3$$

The value w is not the total weight, because arteria branchialis is severed immediately after capture. In all probability, however, the ratio *loss of blood/weight of fish* is nearly constant, and taking the strict correlation between w and w' into consideration, the weight w' should be useable in describing the relative size of the fish.

Table 2 shows the yearly mean weight of tuna and the monthly deviations from this weight in July, August, and September. The table comprises nearly all fish landed.

(b) When the gutted fish is delivered to the buyer, the tuna is weighed individually. Usually the sales organizations take only an interest in number of fish and total weight of the landings, but after agreement with the Institute of Marine Research the organizations now collect weight slips, on which the individual weights (w') are entered. The slips are dated, and the name of landing station is recorded. There is one slip for each landing. The Institute has received such weight slips in the following years: in 1954 and 1955 from district VI; in 1956 from II, III, and VI; in 1957 from II, V, and VI; and in 1958 from all the districts (I—VIII).

The material comprises the individual weights of 113,485 tuna. The yearly catches landed in the districts are treated separately. The first grouping of the material is based upon the time of catching, choosing a week as unity. The weeks are designated by their numbers in the year, disregarding the periodical fluctuation in the datings. The weekly catches are further broken down into groups of 5 kg with group means of 12, 17, 22 ... etc. and the frequency is calculated after the formula

Table 2. Yearly mean weight (kg) of gutted tuna (rows total) landed in districts I—VIII in 1954—58. The rows J, A and S show the deviation from the yearly mean in July, August, and September respectively

(x denotes the case where only the weight has been available)

		Districts															
		I		II		III		IV		V		VI		VII		VIII	
		n	$\overline{w'}$	n	$\overline{w'}$	n	$\overline{w'}$	n	$\overline{w'}$	n	$\overline{w'}$	n	$\overline{w'}$	n	$\overline{w'}$	n	$\overline{w'}$
1954	J.	1572	−13	10944	0	1161	−2	x	—	1479	+18	3424	+10	656	+2	0	—
	A.	9647	+2	525	+11	50	+40	0	—	2515	−2	15877	+4	30	+4	28	+46
	S.	0	—	0	—	3	+21	0	—	381	−53	2738	−36	36	−38	2994	−1
	Total	11219	176	11469	170	1214	169	x	—	4375	118	22039	112	722	113	3022	48
1955	J.	0	—	3785	−7	6887	−2	1197	+9	x	—	10858	+37	560	+31	367	+50
	A.	0	—	914	+22	1430	+8	524	+18	x	—	10570	+3	313	−17	311	+21
	S.	0	—	255	+28	3	+16	212	−95	x	—	13884	−31	206	−58	1306	−20
	Total	0	—	4954	170	8320	166	1933	157	x	—	35312	110	1079	129	1984	92
1956	J.	14	−3	157	−6	4922	−3	x	—	157	+21	701	+17	0	—	0	—
	A.	34	+2	980	+1	784	+15	x	—	608	+19	10630	+17	0	—	0	—
	S.	0	—	4	+23	2	+29	0	—	3283	−5	5415	−36	0	—	0	—
	Total	48	178	1141	188	5708	173	x	—	4048	133	16746	137	0	—	0	—
1957	J.	0	—	886	−5	90	−2	310	+40	1529	+43	4597	+38	123	+42	0	—
	A.	631	0	2756	+2	427	+2	77	+28	1501	+5	7423	−6	789	−3	270	+47
	S.	0	—	18	+38	46	−17	1726	−8	5543	−13	10139	−13	483	−5	1010	−13
	Total	631	176	3660	173	563	179	2113	136	8573	105	22159	104	1395	94	1280	80
1958	J.	0	—	138	−18	162	−5	0	—	56	+57	28	+62	0	—	0	—
	A.	769	−1	1154	−2	389	+2	357	+48	2198	+31	1355	+38	22	+49	0	—
	S.	11	+32	376	+12	0	—	2000	−9	3938	−18	7361	−7	857	−1	181	0
	Total	780	199	1668	200	551	193	2357	125	6192	123	8744	104	879	91	181	107

$$p_{ij} = \frac{n_{ij} \cdot 1000}{n_i}$$

where n designates number of sampled specimens, i the week, and j the weight group. Tables 3—14 show the frequencies of p for different years and fishing areas (districts). C denotes the number of fish caught.

(c) Age determination of 427 tuna has been based upon the study of the concentric zones in the vertebrae, which were stained with alizarin Red S, as used by GALTSOFF (1952). The vertebrae contain from 5 to 13 zones, and in Table 15 is given the mean value and standard deviation of commercial weight (w') of fish with the same number of zones in the vertebrae. The mean length is also included. The zones have been found to be true year zones. As no significant differences between males and females appeared, sex has been disregarded in the grouping. The material consists of three samples (1955, 1956, 1958), which are treated separately. One has been collected from tuna landed in districts III and IV in the middle of July 1956, and two from tuna landed in district VI in the first and last half of September 1955 and 1958 respectively.

(d) It is well known among the Norwegian fishermen that the unequal size groups of tuna appear at different times in the fishing season, especially on the west coast (districts V—VII). The largest tuna always arrive first, the smaller ones some weeks later. The present material gives more detailed information with respect to this observation.

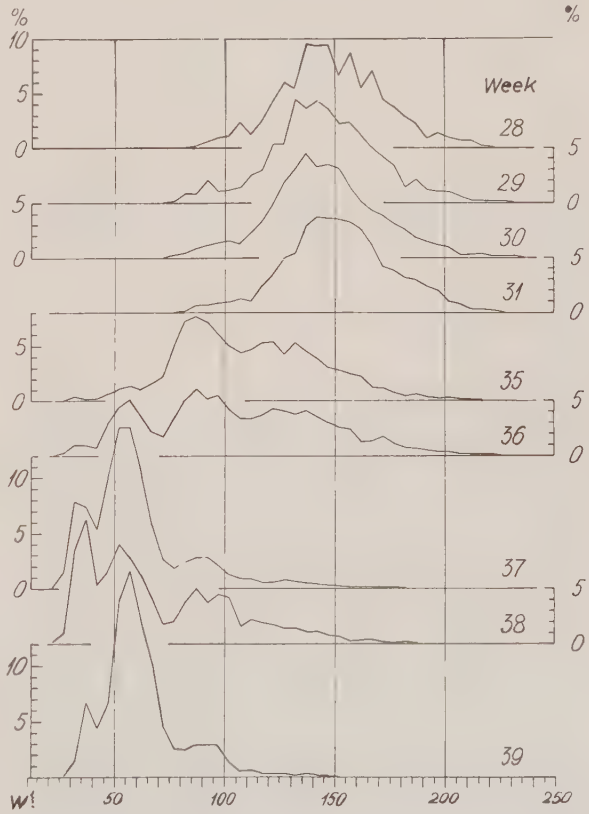

Figure 7. The weekly weight distributions (w' = kg) of Norwegian tuna landed in district VI, 1955.

Table 3. Weight frequency distribution (‰) of Norwegian caught tuna, for the districts II and III in 1956

Group mean (kg)	Districts and week numbers II 30	31	32	34	III 28	29	30	31	32	33	Total
82	—	—	—	—	3	—	1	—	—	—	x
87	—	—	—	—	3	—	1	—	—	—	x
92	—	—	—	—	—	x	—	—	—	—	x
97	—	—	—	—	—	—	—	—	—	—	—
102	—	—	3	—	—	1	—	—	—	—	1
107	—	—	3	—	—	2	—	—	—	—	1
112	—	—	—	—	—	3	1	—	—	—	1
117	—	—	—	—	3	2	1	4	—	—	1
122	—	4	—	—	3	5	5	—	—	—	4
127	—	4	—	—	—	7	11	—	3	—	6
132	—	4	3	—	3	16	17	14	3	—	13
137	—	20	6	—	3	27	36	11	17	—	24
142	—	45	15	—	15	42	61	25	13	—	40
147	14	33	22	—	53	57	66	25	10	—	50
152	57	41	37	29	44	77	75	47	13	—	64
157	29	90	37	—	71	96	93	90	13	105	82
162	86	65	64	—	83	94	104	97	53	—	89
167	86	82	61	29	100	83	81	79	57	53	80
172	129	98	55	57	124	95	71	79	63	53	86
177	29	69	85	29	86	92	86	68	77	211	85
182	29	123	100	57	127	71	75	25	97	105	78
187	57	61	73	43	41	58	53	79	100	105	60
192	100	45	76	157	50	53	45	47	83	—	55
197	71	41	55	29	47	40	30	79	80	105	44
202	29	37	73	114	62	26	33	43	47	53	37
207	57	45	49	43	9	15	20	36	53	53	24
212	71	16	49	114	27	15	14	32	50	53	22
217	43	33	52	86	6	12	6	22	40	53	17
222	29	16	34	43	21	5	6	14	43	53	12
227	29	20	15	71	12	3	2	22	23	—	8
232	14	—	18	43	6	2	2	14	27	—	6
237	—	8	6	—	—	3	3	11	10	—	4
242	29	—	6	43	—	x	2	11	7	—	3
247	—	—	—	—	—	—	1	11	3	—	1
252	—	—	—	—	—	—	—	4	3	—	x
257	—	—	—	—	—	—	—	4	—	—	x
262	—	—	3	—	—	—	—	4	7	—	1
267	—	—	3	—	—	1	—	—	3	—	1
272	—	—	—	—	—	—	—	4	—	—	x
277	—	—	—	—	—	—	—	—	—	—	—
282	—	—	—	—	—	—	—	—	—	—	—
287	—	—	—	14	—	—	—	4	—	—	x
292	—	—	—	—	—	—	—	—	—	—	—
297	14	—	—	—	—	—	—	—	—	—	x
n	70	245	329	70	339	2,417	1,287	279	300	19	5,355
C	70	260	329	79	616	2,878	1,287	512	343	35	6,409

In order to show how the weight composition of the tuna stock changes its character during a season, the landings in district VI 1955 (Table 10) may be chosen, and a graphical demonstration of the weight frequency distribution of weekly catches is shown in Figure 7. It is quite clear that the marked changes in the weight distribution pattern of the tuna catches appearing from Figure 7, must be caused by corresponding changes in the tuna stock, i.e., that there are more than one influx of tuna during the season. Three separate runs of tuna may easily be pointed out. The first one, which comprises the largest tuna, has occurred in weeks 28—31 (in the weeks 32—34 only sporadic catches have been landed). The second run, in which smaller tuna occur, has reached the coast in week 35. In week 36 the tuna fishery was based upon fish from the second run mainly, but at the

Table 4. Weight frequency distribution (‰) of Norwegian caught tuna, for district II in 1957

Group mean (kg)	Week numbers 30	31	32	33/34	Total
52	—	1	—	—	1
57	—	1	—	—	1
62	—	—	—	—	—
67	—	—	—	—	—
72	—	—	—	—	-
77	—	—	3	—	1
82	—	1	—	—	1
87	—	1	—	—	1
92	—	1	3	—	1
97	—	1	—	—	1
102	—	—	3	—	1
107	3	5	10	—	5
112	3	5	—	—	3
117	3	7	—	—	4
122	8	5	—	—	4
127	—	8	10	—	6
132	21	10	—	—	10
137	15	29	17	—	22
142	21	53	41	14	41
147	51	63	51	27	57
152	75	75	82	—	73
157	64	68	65	14	64
162	113	112	72	14	101
167	123	105	89	54	104
172	98	118	123	54	111
177	98	80	72	54	82
182	80	80	89	68	81
187	36	47	79	149	55
192	54	38	65	68	48
197	28	31	31	135	35
202	21	30	34	81	32
207	21	6	21	27	13
212	28	7	—	14	11
217	10	4	21	68	11
222	10	1	7	27	6
227	5	4	—	54	6
232	3	2	10	27	5
237	3	1	—	14	2
242	—	—	—	14	1
247	—	—	—	—	—
252	3	—	—	14	1
257	3	—	—	—	1
262	—	—	—	—	
267	—	—	—	14	1
272	—	—	—	—	—
277	—	—	—	—	—
282	—	—	—	—	—
287	—	—	—	—	—
292	—	—	—	—	—
297	—	—	—	—	—
302	—	—	-		
307	3	—	—	—	1
n	389	838	292	74	1,593
C	389	1,019	919	1,147	3,474

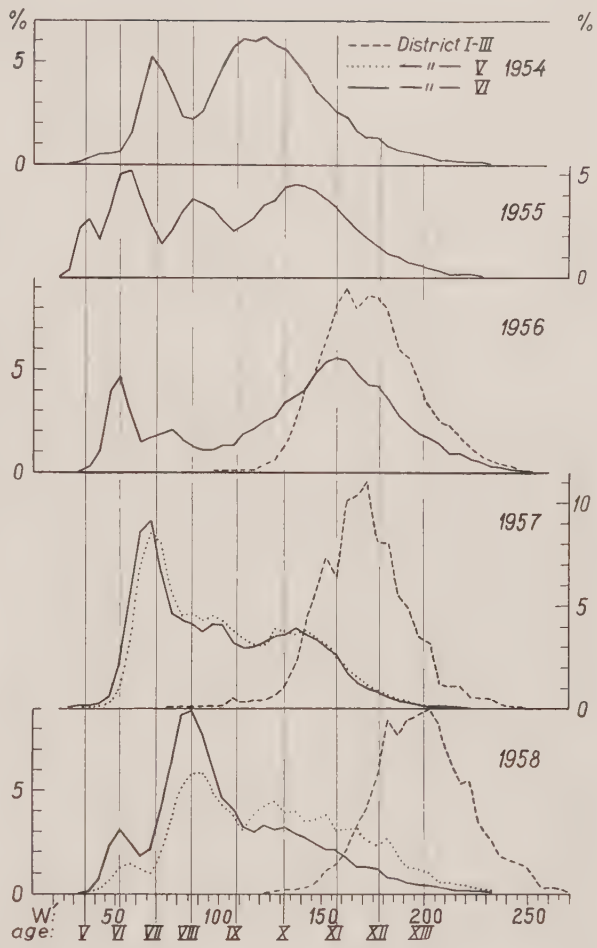

Figure 8. Weight composition (w' = kg) of Norwegian tuna landings by districts, 1954—1958.

end of the week a new smaller size group of tuna appeared in the catches. A closer examination of the weight slips shows that the smaller size groups were not commonly mixed with the greater fish. A few days after the fish from the third run occur, the fish from the second one disappear from the catches (notice also the decrease in C, Table 10). Exactly the same feature can be recognized in the other years (Tables 9—13), and comparing the weight composition pattern of corresponding runs (the first run in the years 1954—1956, the second one in 1954 and 1955, and the last run in 1955—1958), the following conclusion may be drawn (see also Fig. 8): The tuna stock which appears on the west coast of Norway consists of several distinct contingents which invade the coastal waters in succession; up to three separate runs have occurred in one season. The first one is always composed of

Table 5. Weight frequency distribution ($^0/_{00}$) of Norwegian caught tuna, for districts I, II, and III in 1958

Group mean (kg)	I 34	I 35	I 36	II 31	II 32	II 33	II 34	II 35	II 36	III 31	III 32	III 33	III 34	III 35	III 37	Total
122	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	x
127	2	—	—	—	—	—	—	—	—	—	—	36	—	—	—	1
132	—	—	—	—	—	—	2	—	—	4	—	54	—	—	—	2
137	2	7	—	7	—	—	2	—	—	4	8	—	—	—	—	2
142	2	—	—	—	—	—	2	11	—	8	—	—	—	—	—	3
147	6	7	—	20	18	—	6	3	3	—	8	18	—	—	—	5
152	6	3	—	47	18	4	16	11	—	17	8	54	—	—	—	11
157	6	10	—	33	88	7	9	17	3	17	48	54	—	—	—	14
162	26	17	—	47	123	14	16	23	3	25	16	71	—	—	—	21
167	21	24	—	100	88	14	20	23	16	67	71	54	83	—	47	33
172	41	34	—	53	140	18	40	45	8	84	71	54	83	—	47	42
177	49	71	—	133	158	50	49	37	37	92	56	54	125	—	—	58
182	88	68	—	107	70	103	82	98	48	130	95	161	83	—	23	86
187	94	85	91	127	53	92	100	39	27	88	127	36	63	35	23	77
192	73	78	—	73	70	128	91	76	83	96	111	36	104	35	47	85
197	94	102	—	80	105	99	87	96	72	54	111	89	63	35	93	87
202	103	102	91	60	18	85	127	107	83	50	56	36	63	104	47	90
207	114	119	91	27	18	103	87	56	88	50	32	54	63	241	47	82
212	64	68	—	27	18	57	60	84	93	59	48	54	21	69	116	65
217	60	54	91	13	—	64	51	48	80	29	71	18	63	35	23	53
222	54	68	91	20	—	53	60	67	75	42	16	18	63	69	93	55
227	24	17	91	7	—	32	33	34	77	29	8	18	21	—	70	32
232	21	17	—	—	18	25	22	39	53	17	16	—	21	172	23	27
237	21	3	—	7	—	21	11	20	48	4	—	—	—	69	47	18
242	17	14	—	—	—	14	7	28	27	13	16	18	—	69	47	16
247	4	10	182	7	—	11	9	17	24	8	—	18	83	—	140	14
252	6	14	182	7	—	4	2	6	24	13	8	—	—	—	47	10
257	—	7	—	—	—	—	5	6	3	—	—	—	—	—	—	2
262	—	—	—	—	—	4	2	3	13	—	—	—	—	—	—	3
267	—	3	—	—	—	—	—	6	11	—	—	—	—	35	23	3
272	—	—	—	—	—	—	—	—	—	—	—	—	—	35	—	x
277	—	—	91	—	—	—	—	—	5	—	—	—	—	—	—	1
282	—	—	—		—	—	—	—	—	—	—	—	—	—	—	—
287	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	x
n	467	295	11	150	57	282	449	356	376	239	126	56	48	29	43	2,984
C	471	298	11	150	57	282	449	356	376	243	171	56	51	30	43	3,044

the older age-groups, the smaller and younger fish being found later. These same contingents may visit the area concerned for several years in succession.

In Figure 8 the weight compositions of the material from district VI, grouped in yearly catches (Tables 9—13, columns total) are illustrated. Corresponding curves for the districts I—III and V (Tables 3—5 and 7—8) are included in the figure. In order to point out the year-classes which have been most numerous in the catches, the mean weights of the age-groups V—XIII (Table 15) are marked on the abscissa. The material for the age determination is, however, inadequate, and the strength of year-classes can be only approximately determined.

Studying Figure 8 (curves of district VI), it should be borne in mind that the multimodal curves include fish from several distinct immigrations. Two separate runs of tuna have thus formed the bimodal curve of 1954. The peak to the right is mainly caused by the first run, that to the left by the second one. The first run seems to be dominated by the 1944 and 1945 year-classes, the second one by the 1947 year-class, but is considerably mixed with fish from the 1945 year-class (as to details, see the tables). The contingent characterized by the year-classes of 1944 and 1945 has visited the area concerned both in 1955 and 1956, but in later years this contingent cannot be recognized in the catches from district VI. Attention may be drawn to the fact that the relative strength

Table 6. Weight frequency distribution (‰) of Norwegian caught tuna, for district IV in 1958

Group mean (kg)	Week numbers 33	34	37	38	39	40	Total
42	—	—	13	8	—	—	6
47	—	—	17	22	—	—	12
52	—	—	76	34	—	—	29
57	—	—	67	24	—	—	23
62	—	—	29	16	—	—	12
67	—	—	17	20	—	5	12
72	—	—	67	52	—	—	35
77	—	—	71	64	—	5	41
82	—	—	71	74	—	19	48
87	—	—	80	70	17	19	49
92	—	—	76	62	17	10	43
97	—	—	42	58	50	5	36
102	—	—	38	46	17	10	29
107	—	—	21	18	17	19	16
112	—	—	29	36	17	19	25
117	6	35	17	32	50	29	26
122	35	35	71	28	50	53	43
127	12	35	42	24	50	24	27
132	29	35	29	28	83	38	33
137	29	35	29	48	167	77	52
142	41	103	29	34	34	72	42
147	35	35	13	34	34	53	33
152	41	35	4	26	67	77	35
157	70	103	4	14	67	72	35
162	105	35	13	28	83	43	41
167	52	35	4	12	34	67	27
172	58	—	4	10	17	38	21
177	81	138	—	8	—	72	31
182	64	35	4	6	17	38	21
187	122	35	8	10	83	14	31
192	35	35	4	14	—	19	16
197	41	103	8	8	—	29	20
202	35	69	—	10	17	24	16
207	41	—	—	8	17	19	13
212	29	35	—	4	—	14	9
217	6	—	—	2	—	—	2
222	12	—	—	2	—	—	3
227	—	35	—	2	—	10	3
232	—	—	—	2	—	—	1
237	6	—	—	—	—	—	1
242	6	—	—	—	—	—	1
247	12	—	—	—	—	5	3
252	—	—	—	—	—	—	—
257	—	—	—	2	—	—	1
n	172	29	238	500	60	208	1,207
C	189	149	541	978	412	208	2,477

of the 1944 year-class evidently has decreased during the three years, a circumstance which will be dealt with later.

With respect to the contingent which was dominated by the 1947 year-class, it appeared in 1955, but was for some unknown reason absent in 1956. It is fairly definite that the fish from this expected second immigration were not caught on any part of the Norwegian coast that year.

The weight composition pattern of the first run in 1957 indicates that the majority of the fish was of the 1947 year-class. Judging from the general features of Figure 8, it seems fair to assume that these fish belong to the contingent which was absent in 1956. The small number of old tuna caught in 1958 indicates that this contingent is now disappearing from the area concerned (district VI).

A contingent of tuna which has been dominated by the 1950 year-class, can easily be recognized in the catches since 1955. This contingent has been mixed with tuna of the 1949 year-class (even dominating in 1955), and, in last year's season (1958), of the 1952 year-class. Combining the results of the age composition of the tuna contingents mentioned, the investigation shows that the different year-classes must be of very variable strength.

From Table 2 will be noticed that the statistical notations fall within two main groups. Those to the left show the highest mean value, increasing during the season, to the right we find smaller fish, decreasing considerably from month to month. This evidence makes it natural to divide the Norwegian tuna fishing grounds into two areas, one southern, which includes the districts V—VIII, and a northern one including the districts I—III. The district IV may be regarded as a transition area, being in the early season apparently frequented by fish belonging to the northern area, while later in the season by fish from the southern one. Further observations are, however, necessary to clarify this question.

It seems to be evident that the tuna in the North belong to one run each year, the increase in weight being caused by a rapid growth in weight during the season. This apparent growth-rate must be taken into consideration in comparing the statistical parameters of age calculations to the frequency curves in Figure 8. The similarities in the curves of 1957 and 1958 (districts I—III) indicate that the same tuna contingent has been present two years in succession.

Concerning the relationship between the tuna in the northern and southern areas, attention may be drawn to the fact that in 1954—57 the yearly average weight of tuna in the north has been approximately constant (Table 2). This may evidence that in the years 1955—57 the contingent has received recruits from younger year-classes. The smaller peaks in the curves in Figure 8 (those of the weight groups 162 kg in 1956 and 152 kg in 1957, districts I—III) may be indications of such recruitments.

Previously it has been mentioned that the relative strength of the year-classes forming the first run in the south seems to have changed in the years

Table 7. Weight frequency distribution (‰) of Norwegian caught tuna, for district V in 1957

Group mean (kg)	Week numbers 29	30	31	32	34	35	36	37	38	39	40	41	Total
22	—	—	—	—	—	—	—	—	—	1	—	—	x
27	—	—	—	—	—	—	—	—	—	—	—	—	—
32	—	—	—	—	—	—	—	—	—	—	—	—	—
37	—	—	—	—	—	—	—	—	1	2	2	—	1
42	—	—	—	—	—	3	—	1	1	2	2	5	1
47	—	—	—	—	—	8	-	5	4	1	4	2	3
52	2	—	11	—	6	22	18	16	15	4	11	2	11
57	—	—	—	—	41	46	9	49	45	21	43	16	32
62	—	—	11	—	45	51	52	111	116	53	93	44	70
67	2	—	11	—	29	44	61	131	143	72	139	62	85
72	2	—	11	—	6	32	39	107	117	84	189	112	79
77	—	—	—	—	10	36	52	65	85	67	119	62	57
82	—	1	21	—	19	29	83	62	67	41	65	46	45
87	3	6	53	—	26	37	70	73	66	36	54	50	46
92	5	6	53	—	38	57	74	42	55	41	52	44	43
97	3	8	32	—	41	61	92	63	47	46	26	55	45
102	16	14	11	—	64	42	57	52	43	51	33	66	42
107	13	18	84	63	32	51	26	34	31	53	33	57	37
112	13	21	64	—	67	44	39	36	34	40	26	25	34
117	9	17	42	—	70	47	39	27	26	43	9	34	31
122	20	34	74	125	80	50	31	21	16	40	20	28	31
127	31	55	32	188	96	63	61	26	17	46	20	39	38
132	47	80	53	125	48	53	31	21	16	47	11	48	37
137	75	90	95	63	67	44	39	12	15	39	6	37	36
142	109	90	105	63	45	48	35	15	12	41	9	34	38
147	98	108	53	63	57	39	31	7	8	34	4	39	34
152	108	111	53	—	51	27	—	6	7	30	2	21	30
157	100	79	32	125	35	27	9	5	4	19	6	21	25
162	86	67	32	—	6	18	22	2	2	9	6	9	19
167	62	63	21	125	10	9	13	4	1	14	7	14	16
172	65	42	21	63	—	8	4	1	2	7	4	7	12
177	39	35	11	—	3	3	9	4	2	1	2	7	8
182	31	21	—	—	6	1	—	1	1	4	2	2	6
187	19	7	11	—	3	3	4	—	x	4	—	5	3
192	20	6	—	—	—	1	—	1	x	3	—	5	3
197	9	8	—	—	—	1	—	—	x	4	2	2	2
202	6	7	—	—	—	—	—	—	x	—	—	—	1
207	5	1	11	—	—	—	—	1	1	—	—	2	1
212	2	3	—	—	—	—	—	1	—	—	—	—	x
217	—	—	—	—	—	-	—	—	—	—	—	—	—
222	2	—	—	—	—	—	—	—	x	—	—	—	x
227	—	1	—	—	—	—	—	—	—	—	—	—	x
232	2	—	—	—	—	—	—	—	—	—	—	—	x
237	—	—	—	—	—	—	—	—	x	—	—	—	x
n	642	712	95	16	314	1,207	229	1,285	2,260	1,353	539	437	9,089
C	692	788	98	16	325	1,207	229	1,337	2,454	1,370	539	475	9,530

1954—56, the abundance of the oldest tuna, presumed to be of the 1944 year-class, having decreased. Since 1956 this contingent has been absent from the southern area.

These results combined argue that the recruitment of tuna to the northern area takes place at the cost of the tuna occurring in the southern one, that is, the tuna change their feeding area from south to north when reaching a certain age (size); but it cannot as yet be said with certainty whether or not the various contingents belong to the same population.

Table 8. Weight frequency distribution (‰) of Norwegian caught tuna, for district V in 1958

Group mean (kg)	Week numbers 29	30	32	33	34	35	36	37	38	39	40	Total
37	—	—	—	—	—	8	—	3	—	—	3	1
42	—	—	—	—	—	4	—	11	4	2	—	2
47	—	—	—	—	1	—	—	16	19	7	6	6
52	—	—	—	—	—	11	—	19	34	16	14	12
57	—	—	—	—	—	—	—	13	33	27	8	14
62	—	—	—	—	—	8	5	16	29	18	18	12
67	—	—	—	—	—	—	5	35	19	16	10	10
72	—	—	—	—	3	34	12	37	42	25	24	20
77	—	—	—	2	1	26	40	96	58	58	30	37
82	—	—	—	2	7	34	26	115	93	79	57	51
87	—	—	—	4	11	22	19	94	97	100	64	57
92	—	—	—	1	6	37	9	88	82	115	78	58
97	—	—	—	7	15	19	24	62	55	94	75	49
102	—	—	—	6	22	22	21	40	65	78	46	43
107	—	—	—	11	22	37	5	59	44	66	48	38
112	—	—	—	16	39	30	26	32	30	40	40	31
117	—	—	—	25	50	52	45	48	34	44	33	38
122	—	—	—	44	64	37	54	35	31	40	37	42
127	—	—	125	53	64	82	56	35	24	36	45	45
132	—	—	—	57	62	56	42	32	37	20	41	40
137	—	35	—	38	65	75	70	21	35	29	40	41
142	—	35	—	45	55	67	47	11	22	18	48	35
147	—	35	—	53	59	63	68	21	14	14	41	36
152	—	35	—	49	75	45	96	16	22	16	33	38
157	83	69	—	62	33	49	47	24	13	9	38	31
162	—	172	125	64	46	37	45	3	12	10	30	31
167	83	103	—	71	36	22	52	5	9	6	29	30
172	167	69	—	59	53	22	28	5	10	5	16	26
177	83	35	250	64	43	22	26	3	4	3	8	24
182	167	138	—	75	42	19	35	3	3	3	11	27
187	—	—	125	52	29	15	2	—	8	3	11	18
192	—	35	125	39	22	4	21	—	4	1	2	13
197	—	35	125	26	14	19	33	—	1	2	10	12
202	83	35	—	28	14	8	14	—	4	2	2	10
207	250	—	125	13	12	4	9	—	2	1	—	6
212	83	69	—	10	11	4	9	—	1	1	2	5
217	—	69	—	12	7	—	5	—	2	1	—	4
222	—	35	—	7	3	—	—	—	1	—	3	2
227	—	—	—	2	7	4	—	—	1	—	—	2
232	—	—	—	1	3	—	—	3	1	—	2	1
237	—	—	—	2	3	—	—	—	—	—	—	1
242	—	—	—	—	1	—	—	—	—	—	—	x
247	—	—	—	1	—	4	5	—	—	—	—	1
252	—	—	—	—	1	—	—	—	1	—	—	x
n	12	29	8	1,396	723	268	426	374	1,000	1,771	629	6,636
C	27	29	8	1,396	753	268	459	454	1,022	1,771	706	6,893

Table 9. Weight frequency distribution (‰) of Norwegian caught tuna, for district VI in 1954

Group mean (kg)	Week numbers 28	29	30	31	32	33	34	35	36	37	38	39	40	41	Total
32	—	1	—	—	—	x	x	2	—	9	5	—	—	2	1
37	2	2	—	—	x	2	1	6	5	28	11	—	24	9	3
42	—	4	—	—	x	x	3	9	3	38	9	4	44	21	5
47	2	1	—	—	x	x	2	5	9	30	17	20	15	37	5
52	2	—	—	—	x	x	4	13	16	19	13	16	44	32	6
57	—	6	—	4	x	3	15	42	62	42	36	53	49	38	15
62	2	20	—	3	2	7	32	88	112	79	90	130	93	101	34
67	10	35	—	10	3	13	46	110	148	127	144	190	137	210	52
72	22	15	—	22	5	12	39	78	121	105	147	243	190	186	46
77	12	24	—	15	4	11	33	59	74	64	76	121	185	179	35
82	20	18	—	11	5	13	21	28	57	48	50	32	83	86	23
87	7	12	—	10	7	19	25	35	48	28	41	65	44	43	22
92	12	26	—	11	13	29	30	37	43	31	37	40	29	21	26
97	34	33	—	27	22	46	43	55	43	51	48	32	29	10	37
102	39	49	—	44	36	58	56	59	48	56	48	20	10	11	48
107	69	53	—	49	51	78	64	55	49	36	42	16	5	7	57
112	49	66	—	56	57	82	69	65	45	43	35	12	10	1	61
117	51	51	—	64	68	82	65	57	27	38	42	—	5	1	60
122	88	68	—	66	85	79	64	36	23	23	32	—	—	—	62
127	88	55	—	84	79	74	59	32	16	31	20	4	—	2	58
132	71	61	—	91	86	77	47	28	9	17	13	—	5	1	56
137	64	53	—	78	80	62	46	23	15	13	7	—	—	—	50
142	61	52	—	54	67	55	42	22	7	13	7	—	—	—	44
147	39	42	—	47	58	42	36	11	3	6	9	—	—	—	35
152	42	44	—	47	49	32	32	15	2	6	3	—	—	—	31
157	42	35	—	38	43	29	20	9	2	3	4	—	—	—	25
162	49	38	—	32	40	20	22	4	3	1	4	—	—	—	23
167	22	31	—	23	25	17	14	6	1	3	3	—	—	—	16
172	20	16	—	26	22	11	14	4	—	4	2	—	—	—	13
177	17	21	—	23	24	11	14	3	1	1	1	—	—	—	13
182	12	15	—	15	16	8	9	2	2	—	1	—	—	—	9
187	10	17	—	8	12	6	7	1	—	3	1	—	—	—	7
192	7	12	—	14	11	5	6	1	—	3	—	—	—	—	6
197	12	8	—	12	8	4	7	—	1	1	—	—	—	—	5
202	7	7	—	4	7	4	4	—	1	—	—	—	—	—	4
207	5	3	—	4	5	3	2	—	—	—	—	—	—	—	2
212	2	1	—	4	4	2	2	—	1	—	—	—	—	—	2
217	2	1	—	—	2	1	1	—	—	—	—	—	—	—	1
222	5	2	—	4	1	2	1	—	1	—	—	—	—	—	1
227	—	—	—	—	1	1	1	—	—	—	—	—	—	—	1
232	—	—	—	—	x	x	1	—	—	—	—	—	—	—	x
237	—	—	—	—	x	x	x	—	—	—	—	—	—	—	x
242	—	—	—	—	1	1	x	—	—	—	—	—	—	—	x
247	—	—	—	—	—		—	—	—	—	—	—	—	—	—
252				—	—	—	—	—	—		—	—	—	—	—
257	—	—	—	—	—	—	x	—	—	—	—	—	—	—	x
262	—	—	—	—	x	—	—	—	—	—	—	—	—	—	x
267	—	—	—	—	—	—	—		—	—		—		—	—
272	—	—	—	—	—	x	x	—	—	—	—	—	—	—	x
n	409	1,442	—	729	4,186	4,267	4,850	974	955	702	951	247	205	810	20,727
C	412	1,966	—	911	4,612	4,654	5,290	1,001	959	764	951	247	205	834	22,828

Table 10. Weight frequency distribution (‰) of Norwegian caught tuna, for district VI in 1955

Group mean (kg)	Week numbers 28	29	30	31	32	33	35	36	37	38	39	Total
12	—	—	—	—	—	—	—	—	3	—	—	1
17	—	—	—	—	—	—	—	—	2	—	—	x
22	—	—	—	—	—	—	—	x	1	2	—	x
27	—	—	—	—	—	—	x	3	15	10	1	4
32	—	—	—	—	—	—	4	10	78	83	15	24
37	—	—	—	—	—	—	1	10	73	112	67	28
42	—	—	x	—	—	—	2	8	53	54	43	18
47	—	—	—	—	—	—	6	29	100	66	66	32
52	—	—	1	—	—	—	11	44	147	90	157	50
57	—	—	1	—	—	—	14	51	148	78	185	52
62	2	1	2	x	—	—	11	36	105	61	141	38
67	4	1	1	1	—	—	16	22	56	39	101	25
72	—	—	1	x	—	—	22	18	26	18	46	16
77	—	1	3	x	—	—	48	34	18	20	25	23
82	—	8	5	1	4	—	73	51	24	38	24	32
87	2	8	10	7	—	8	76	61	28	50	29	38
92	6	21	12	7	—	8	72	52	28	38	29	36
97	9	9	15	9	13	—	60	55	21	45	29	33
102	8	11	16	10	4	—	49	42	12	42	13	27
107	23	14	14	13	9	—	44	34	9	16	5	22
112	13	25	23	11	9	—	47	34	9	22	6	25
117	28	29	33	25	39	56	53	37	5	20	3	29
122	45	54	48	35	39	40	54	43	6	17	3	35
127	60	53	70	50	26	48	42	41	8	14	3	37
132	54	95	81	54	44	56	53	38	6	15	3	44
137	96	85	96	79	100	64	45	41	5	11	1	45
142	94	93	84	87	65	104	39	36	4	12	3	44
147	94	85	85	86	135	144	30	30	3	8	1	42
152	66	72	83	85	100	88	27	26	2	7	1	38
157	87	73	62	83	109	96	25	24	1	3	—	34
162	55	60	50	77	68	48	22	13	1	4	—	28
167	70	50	43	61	74	80	13	14	1	4	1	23
172	43	42	38	42	52	56	12	17	1	2	—	19
177	38	34	30	39	22	40	7	11	1	x	—	15
182	32	14	26	32	30	8	4	8	x	—	—	11
187	21	21	18	30	17	16	6	7	x	1	—	10
192	8	13	15	24	17	24	3	6	—	x	—	7
197	13	10	12	20	9	8	1	4	x	—	—	6
202	9	10	10	10	4	—	3	4	—	x	—	4
207	8	5	4	9	—	—	1	2	—	—	—	3
212	8	3	3	3	4	—	1	1	—	—	—	1
217	2	1	4	3	—	8	x	1	—	—	—	1
222	—	1	1	2	4	—	x	1	—	—	—	1
227	—	2	x	x	—	—	x	—	—	—	—	x
232	—	—	1	1	—	—	—	x	—	—	—	x
237	—	—	x	—	—	—	x	x	—	—	—	x
242	—	—	—	1	—	—	x	x	—	—	—	x
247	2	—	1	1	—	—	—	—	—	—	—	x
252	—	—	—	x	—	—	—	x	—	—	—	x
n	524	1,793	3,077	2,310	229	125	4,485	3,819	3,845	2,297	1,190	23,694
C	533	2,716	4,589	3,020	229	238	5,802	8,545	4,513	3,720	1,276	35,100

Table 11. Weight frequency distribution (‰) of Norwegian caught tuna, for district VI in 1956

Group mean (kg)	Week numbers 28	29	30	31	32	33	34	35	36	37	38	39	Total
22	—	—	—	—	—	—	—	x	—	—	—	—	x
27	—	—	—	—	—	—	—	—	—	—	—	2	x
32	—	—	—	—	—	—	—	x	—	—	1	—	x
37	—	—	—	—	—	—	—	1	16	29	13	4	3
42	—	—	—	—	—	—	1	1	26	73	44	37	11
47	—	—	—	—	—	3	3	4	118	161	168	67	38
52	—	—	—	—	—	3	1	2	134	120	234	81	46
57	—	—	—	—	—	2	2	1	56	44	137	83	28
62	—	—	—	—	—	—	1	2	20	—	64	73	15
67	—	—	—	—	—	—	4	5	10	29	62	81	17
72	—	—	—	—	11	5	8	9	10	29	58	91	19
77	—	3	—	—	—	10	6	11	10	51	52	101	21
82	—	6	—	—	—	17	6	12	10	7	34	69	16
87	—	—	—	—	—	3	11	8	3	11	29	63	13
92	—	—	—	5	—	12	8	7	3	15	19	45	11
97	37	—	16	5	22	10	6	8	—	—	15	53	11
102	—	6	—	5	11	24	15	11	—	11	15	35	13
107	—	3	—	10	22	19	12	15	7	4	9	14	13
112	—	6	32	10	22	24	24	22	13	4	9	26	19
117	37	10	48	10	33	24	26	24	13	—	7	22	21
122	—	22	16	19	43	43	34	28	—	15	9	6	25
127	—	29	95	19	33	43	28	35	7	4	6	10	27
132	37	70	79	63	98	41	48	38	7	4	2	16	34
137	74	98	127	68	76	72	48	40	7	11	2	6	37
142	56	86	63	53	76	55	52	49	16	15	2	4	40
147	111	114	95	78	76	69	66	58	16	7	2	6	49
152	56	79	48	121	98	88	77	63	46	11	—	—	54
157	56	95	79	73	22	78	75	69	36	29	1	2	56
162	111	105	79	97	65	55	70	69	43	11	1	—	55
167	56	67	16	78	76	53	51	65	39	22	—	2	48
172	37	67	95	58	22	55	55	54	29	36	—	—	43
177	93	32	16	53	98	35	50	56	46	11	2	—	42
182	56	29	16	34	43	36	36	49	56	47	—	—	36
187	130	16	16	15	33	21	30	39	46	15	1	—	28
192	19	13	—	44	—	16	26	31	26	29	1	—	23
197	—	19	32	15	—	19	21	26	36	22	1	—	19
202	19	10	—	24	11	21	19	23	3	22	1	—	17
207	19	13	—	15	—	14	22	18	10	11	—	—	14
212	—	3	16	5	—	14	11	12	10	22	—	—	9
217	—	—	—	10	11	—	15	12	23	7	—	—	9
222	—	—	—	5	—	3	8	7	13	11	—	—	6
227	—	—	—	10	—	3	10	6	3	18	—	—	5
232	—	—	16	—	—	3	8	3	10	11	—	—	3
237	—	—	—	—	—	2	4	3	3	4	—	—	2
242	—	—	—	—	—	—	1	1	7	7	—	—	1
247	—	—	—	—	—	—	2	1	3	4	—	—	1
252	—	—	—	—	—	2	1	1	3	—	—	—	1
257	—	—	—	—	—	—	1	1	—	4	—	—	1
262	—	—	—	—	—	—	—	x	3	—	—	—	x
267	—	—	—	—	—	—	1	x	—	4	—	—	x
272	—	—	—	—	—	—	—	x	3	—	—	—	x
277	—	—	—	—	—	—	—	x	—	—	—	—	x
282	—	—	—	—	—	—	—	—	3	—	—	—	x
n	54	315	63	206	92	571	1,791	5,740	306	274	1,758	493	11,663
C	101	462	69	206	111	571	2,766	8,454	786	276	2,451	493	16,746

Table 12. Weight frequency distribution (‰) of Norwegian caught tuna, for district VI in 1957

Group mean (kg)	Week numbers 29	30	31	32	33	34	35	36	37	38	39	40	41	42	Total
27	—	—	—	—	—	—	x	—	—	—	—	—	—	—	x
32	—	1	—	—	6	2	2	—	1	—	—	—	—	—	1
37	—	—	—	—	—	—	2	—	2	2	—	2	—	—	1
42	—	—	—	—	12	3	3	—	2	2	2	7	—	—	2
47	—	—	—	2	53	9	14	3	6	4	—	2	—	—	6
52	—	1	2	8	165	28	48	14	24	20	2	17	4	—	22
57	4	4	1	22	159	43	119	67	70	50	14	50	8	9	55
62	—	6	1	18	124	52	144	83	128	107	41	96	80	26	85
67	8	5	2	10	35	57	99	113	155	137	48	178	120	9	91
72	—	4	1	7	24	31	63	61	111	104	55	170	155	17	66
77	4	4	3	7	18	41	49	39	65	66	50	106	128	103	46
82	—	7	5	10	24	35	50	38	61	61	37	71	100	43	43
87	4	14	17	17	—	40	51	44	47	57	39	57	68	60	41
92	4	19	22	14	18	48	43	41	54	35	37	44	44	60	37
97	4	21	27	31	—	54	48	61	44	45	50	51	32	43	41
102	16	31	34	35	18	54	47	41	38	42	71	25	8	68	40
107	12	15	26	44	—	56	32	40	28	37	59	20	36	17	32
112	12	21	37	52	18	52	25	34	19	31	46	14	40	17	29
117	24	29	34	30	30	50	27	34	28	28	39	11	24	60	30
122	48	39	49	66	46	46	23	46	19	27	64	11	8	43	32
127	48	51	65	72	24	56	18	37	20	28	62	14	24	34	35
132	56	72	94	79	18	47	21	32	15	19	48	8	8	43	36
137	121	91	85	70	12	46	17	27	15	21	62	11	40	43	39
142	73	93	94	72	12	33	15	32	11	16	46	8	4	43	36
147	108	96	73	74	18	39	12	21	10	13	32	13	8	60	34
152	112	82	87	68	24	20	8	27	6	13	39	6	16	34	30
157	76	73	67	50	59	13	8	15	11	9	25	2	16	43	26
162	52	62	53	20	12	15	5	13	6	5	14	2	—	26	18
167	56	42	32	36	18	3	2	7	2	6	7	2	16	34	13
172	51	36	29	19	18	6	1	7	2	3	2	—	4	26	10
177	24	28	16	20	12	6	1	6	1	4	7	1	—	34	8
182	32	16	15	19	—	7	1	6	1	2	2	—	4	—	6
187	8	15	10	7	—	3	x	4	x	1	—	—	8	9	4
192	16	8	7	6	6	1	1	4	1	x	—	—	—	—	3
197	16	7	5	4	6	—	1	—	—	1	—	—	—	—	2
202	—	5	4	2	—	2	1	1	—	x	—	—	—	—	1
207	—	1	3	1	—	1	x	—	—	x	—	—	—	—	1
212	4	1	1	2	—	1	—	—	—	x	—	—	—	—	1
217	4	1	1	—	6	—	—	2	—	x	—	—	—	—	1
222	—	1	—	2	—	—	—	—	—	x	—	—	—	—	x
227	—	x	—	—	6	—	—	1	—	—	—	—	—	—	x
232	—	—	—	—	6	—	—	—	—	—	—	—	—	—	x
237	—	x	1	—	—	—	—	—	—	x	—	—	—	—	x
242	—	x	—	1	—	—	—	—	—	x	—	—	—	—	x
247	—	x	—	—	—	—	—	—	—	—	—	—	—	—	x
252	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
257	—	—	—	—	—	1	—	—	—	—	—	—	—	—	x
n	249	2,645	1,395	834	170	1,102	3,879	917	2,691	4,308	437	883	251	117	19,878
C	392	3,426	1,559	872	172	1,495	4,104	1,884	3,270	4,539	279	1,001	471	118	23,582

Table 13. Weight frequency distribution (‰) of Norwegian caught tuna, for district VI in 1958

Group mean (kg)	Week numbers 29	32	33	34	35	36	37	38	39	40	41	Total
32	—	—	—	—	—	1	—	—	—	—	—	x
37	—	—	—	—	—	1	—	1	1	—	—	1
42	—	—	—	—	4	12	12	4	7	1	—	7
47	—	—	—	—	4	37	68	10	20	2	—	23
52	—	—	—	—	4	43	71	28	37	6	3	31
57	—	—	—	—	8	28	46	20	42	14	—	25
62	—	—	—	2	4	18	30	19	29	11	—	18
67	—	—	4	—	16	27	44	24	23	8	—	22
72	—	—	8	3	35	50	67	51	39	19	—	40
77	—	—	10	7	47	85	80	85	52	37	17	62
82	—	—	2	9	129	116	113	109	76	56	17	86
87	—	—	6	5	63	110	99	109	85	121	8	88
92	—	—	4	19	98	76	65	100	93	119	28	78
97	—	—	6	21	70	54	50	72	75	121	30	62
102	—	—	6	22	66	38	40	50	52	84	47	46
107	—	42	16	27	35	37	27	39	50	80	41	41
112	—	—	16	41	59	25	19	30	40	55	41	32
117	—	—	20	50	47	24	28	28	27	38	55	30
122	—	83	47	63	63	21	18	30	33	40	55	33
127	—	42	55	67	51	19	16	28	33	32	58	31
132	—	—	68	82	59	27	18	21	24	31	52	32
137	—	83	53	62	39	24	16	25	27	25	44	29
142	71	42	33	94	16	21	12	25	20	23	61	27
147	71	125	57	63	8	20	14	16	20	19	47	24
152	179	125	35	56	23	14	10	13	20	12	83	21
157	36	—	49	51	8	17	9	19	17	14	55	21
162	107	167	70	44	8	13	8	9	13	11	47	18
167	179	42	49	39	4	5	8	6	9	4	52	13
172	107	—	57	34	12	6	6	9	11	10	41	14
177	143	—	63	29	4	6	2	3	7	4	50	11
182	—	83	57	19	4	6	3	3	4	3	22	8
187	36	42	37	29	—	6	2	3	3	1	11	7
192	—	—	41	26	—	2	—	2	3	—	6	5
197	—	42	29	12	—	2	2	1	1	—	3	4
202	36	42	31	5	—	3	—	1	3	1	8	4
207	—	—	25	9	—	3	—	2	1	—	3	3
212	—	42	14	3	4	2	—	1	—	—	8	2
217	—	—	4	2	4	1	—	1	—	—	6	1
222	36	—	12	3	—	—	—	1	1	—	—	1
227	—	—	2	2	4	—	—	2	1	—	—	1
232	—	—	4	—	4	1	—	—	—	—	3	1
237	—	—	4	—	—	1	—	1	—	—	—	1
242	—	—	—	—	—	—	—	—	—	—	—	—
247	—	—	4	—	—	—	—	—	1	—	—	x
252	—	—	—	—	—	—	—	—	—	—	—	—
257	—	—	—	—	—	—	—	—	—	—	—	—
262	—	—	—	—	—	—	—	—	1	—	—	x
267	—	—	—	—	—	—	—	—	—	—	—	—
272	—	—	—	—	—	—	—	—	—	—	—	—
277	—	—	—	—	—	—	—	—	—	—	—	—
282	—	—	—	—	—	—	—	—	—	—	—	—
287	—	—	—	—	—	—	—	—	—	—	—	—
292	—	—	—	—	—	—	—	1	—	—	—	x
n	28	24	489	585	256	2,187	1,247	2,076	1,535	950	363	9,740
C	28	24	489	585	256	2,187	1,247	2,076	1,535	950	363	9,740

Table 14. Weight frequency distribution (‰) of Norwegian caught tuna, for districts VII and VIII in 1958

Group mean (kg	Districts and week numbers VII 37	VII 38	VIII 35	VIII 37	Total
37	—	—	91	—	5
42	5	5	182	—	15
47	19	16	109	8	22
52	27	38	218	—	39
57	14	46	36	8	27
62	44	22	36	—	28
67	41	11	55	—	24
72	57	51	36	—	46
77	128	76	73	—	86
82	150	100	36	40	108
87	160	119	55	96	128
92	120	113	55	56	105
97	71	92	—	72	75
102	54	54	18	48	51
107	27	40	—	—	27
112	25	27	—	64	29
117	16	19	—	16	16
122	11	27	—	32	20
127	—	51	—	48	27
132	8	24	—	56	21
137	14	22	—	56	22
142	11	11	—	96	22
147	—	14	—	88	17
152	—	3	—	16	3
157	—	3	—	24	4
162	—	8	—	48	10
167	—	3	—	16	3
172	—	3	—	16	3
177	—	3	—	16	3
182	—	—	—	16	2
187	—	—	—	—	—
192	—	—	—	—	—
197	—	—	—	16	2
202	—	—	—	16	2
207	—	—	—	8	1
212	—	—	—	—	—
217	—	—	—	8	1
222	—	—	—	—	—
227	—	—	—	8	1
232	—	—	—	8	1
237	—	—	—	—	—
242	—	3	—	—	1
n	368	371	55	125	919
C	372	376	55	126	929

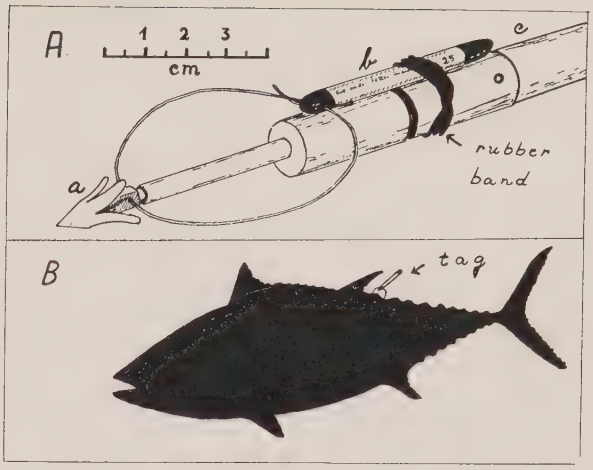

Figure 9. A. The marking harpoon for tuna tagging. (a) Akulon head. (b) Tag. (c) Shaft. B. Approximate position of tag on fish.

Table 15. The lengths and weights by age of Norwegian caught tuna

n = number of sampled specimens, $\overline{w}'$ = mean weight (kg) of gutted fish, s = standard deviation of w', $\bar{l}$ = mean length (cm) of axis from tip of snout to fork of tail

Age-group	Year	n	$\overline{w}'$	s	$\bar{l}$
V	1955	52	35	5.3	135
VI	1955	54	52	5.1	153
	1958	19	55	5.4	154
	Total	73	53	5.3	153
VII	1955	9	64	4.5	161
	1958	16	74	7.5	169
	Total	25	70	8.2	166
VIII	1956	5	91	6.0	180
	1958	47	87	7.4	180
	Total	52	87	7.4	180
IX	1956	5	116	5.2	198
	1958	13	106	9.4	194
	Total	18	109	9.6	195
X	1956	15	132	7.4	207
XI	1956	100	158	15.1	221
XII	1956	79	177	17.5	228
XIII	1956	13	200	16.6	239

II. Tagging experiments

A tuna tagging experiment was performed in September 1957. Twenty-two fish were tagged and released in the fishing localities west of Bergen. The Lea hydrostatic tag was used, attached to the dorsal side by means of a stainless steel harpoon head, inserted in the muscles.

The experiment was continued in 1958, but due to bad fishing conditions only 18 tuna were tagged. The harpoon head has been modified and made of Akulon. The tagging outfit is illustrated in Figure 9.

Only purse seine caught tuna have been used in the experiments, the weight of which was estimated to lie between 50 and 130 kg.

JOHANNES HAMRE

Reference

GALTSOFF, P. S., 1952. "Staining of growth rings in the vertebrae of tuna *(Thunnus thynnus)*". Copeia, 1952 (2): 103 05.

Investigations on the German Tuna Fishery in 1958

(Table 16)

The beginning of the German tuna fishery was delayed in 1958, most likely due to the very cold summer. In August only 20 tunas were landed which is little more than 1% of the total catch. 63% were caught in September and the remainder (36%) in October. The main landing places were Cuxhaven and Hamburg. Only 2.2% of the total catch was landed in Bremerhaven. The small landings inBüsum (0.7%) were sent mainly to Hamburg. The total catch in 1958, that is 1,630 tunas weighing 454.9 metric tons, was much lower than the catch in 1957 (1,285.5 tons) and was even lower than that of 1956 (554.7 tons).

During the first half of September, the main fishing grounds were Baymans Loch and Middle-Reef which yielded respectively 17.9% and 17.8% of the total catch. Only few tunas were caught on the Fladen Ground, Devils Hole, Dogger Bank, Upper Scruff, Ellbogen, and Tail End. During the second half of September, the most productive fishing grounds were the Middle-Reef (27.0%), Ellbogen (12.8%), and South Reef (1.4%). In October the main fishing ground was the Ellbogen area, yielding 15.5%, besides the western part of the Dogger Bank which yielded 6.6%.

The weight of nearly all the tunas landed was recorded. 94.3% of the total landings were measured and their feeding coefficents were calculated. The feeding condition of the tunas was somewhat better than in 1957, but not as good as in 1956, as the figures set out in Table 16 show.

The length composition of the tunas did not differ much from that of 1957. The catch was mainly composed of the strong, old year-class or year-classes which were already caught for the first time in 1952, as stated by Tiews, and which gained considerable importance in the following years.

Table 16. Feeding coefficient of tunas landed in Germany

	August	September	October
1956	1,779	1,914	1,959
1957	1,733	1,770	1,840
1958	1,815[1])	1,840	1,898

[1]) End of August to 15. September 1958.

Small tunas less than 200 cm in length, which had contributed 0.4% of the total catch in 1957 were absent in the 1958 catches.

P. F. Meyer-Waarden

Sur les Thons qu'on Pêche au Portugal

(Tableaux 17–20)

Thunnus thynnus L. est la seule espèce de thon qu'on pêche régulièrement au Portugal, bien que la présence d'autres espèces soit également signalée.

Cette pêche, pratiquée exclusivement dans la côte sud (Algarve), et avec des madragues, est commencée normalement vers le milieu de mai et se termine vers le milieu d'août. On sait que pendant les premiers mois de l'époque (mais/juin, époque de course) les thons se déplacent vers l'est, et à la suite (juillet/août, époque de retour), dans le sens inverse.

Il y a fréquemment des interruptions de la pêche, probablement déterminées par des conditions hydrologiques, locales et occasionnelles, qu'il faut étudier. Dans ce but, et pour connaître les conditions écologiques pendant toute l'année, nous avons initié déjà l'étude de la température et de la salinité de l'eau, et nous avons l'intention de nous occuper également d'autres facteurs de l'ambient.

Cependant les données sur salinité et température obtenues jusqu'à présent nous n'ont pas permis aucunes conclusions sur leur influence. Son étude poursuivra.

L'espèce a été déjà étudiée au Portugal, sous divers aspects de sa biologie et de sa pêche, par

Tableau 17. Poissons reçus par les usines de conserves

1958		Atuns	Atuarros	Albacoras	Cachorretas	Total
Mai	Poids, kg	73.166	8.713	723	115	82.717
	Nombre d'exemplaires	439	119	12	7	577
	Moyenne, kg	166,7	73,2	60,3	16,4	143,4
Juin	Poids, kg	307.071	130.668	3.052	500	441.291
	Nombre d'exemplaires	2.330	1.903	68	78	4.379
	Moyenne, kg	131,8	68,7	44,9	6,4	100,8
Juillet	Poids, kg	65.870	4.746	244	—	70.860
	Nombre d'exemplaires	457	64	5	—	526
	Moyenne, kg	144,1	74,2	48,8	—	134,7
Août	Poids, kg	21.282	1.149	932	—	23.363
	Nombre d'exemplaires	157	15	17	—	189
	Moyenne, kg	135,6	76,6	54,8	—	123,6

Tableau 18. Longueur et poids de *Thunnus thynnus* pêchés par les madragues algarbiennes en 1958

Longueur, cm	Époque de course			Époque de retour			Total	
	Poids, kg	Nombre	Moyenne, kg	Poids, kg	Nombre	Moyenne, kg	Nombre	Moyenne, kg
105–114	28							
110		1	28,0				1	28,0
125–134	53–45			53	1	53,0		
130		2	49,0				3	50,3
135–144	63–60–60–66–67–			45–46	2	45,5		
140	63–55–50–42–52–	11	58,4				12	56,4
145–154	64–73–73–76–70–			52–53–53–60–50–				
150	69–72–70–71–71– 65–73–66–63–61– 63	16	68,8	45–49	7	51,7	23	63,5
155–164	80–75–74–78–87–			68–69–63–80–69–				
160	79–85–86–81	9	80,6	57–58	7	66,3	16	74,3
165–174	97–98–96–102– 100–95–186–77–							
170	99–111–93–93–93 90–85–108–102– 94–90–95–100	21	100,2	74	1	74,0	22	99,0
175–184	109–109–131–106– 110–105–105–106–			92–88–103–101–90– 110–108–111–74–				
180	122–115–103–107– 114–112–115–129– 127–97	18	112,3	103	10	98,0	28	107,2
185–194	135–122–127–145– 123–139–136–143–			120–110–107–110– 135–120–151–98–				
190	147–147–123–115– 133–142–127–133– 137–130	18	133,6	111–95–103–106– 101–99–144–105– 98	17	112,1	35	122,8
195–204	163–193–137–148– 143–147–140–150–			120–121–146–126– 106–103	6	120,3	18	138,6
200	131–142–144–135	12	147,8					
205–214	195–187–199–185			175–150–170–124–				
210	171–170–186–196	8	186,1	133–157–150–155– 146	9	151,1	18	167,6
215–224	229–230–215			210–190–147–179–				
220		3	224,7	150–145–164–173– 154–189–177	11	170,7	14	182,3
225–234	232–232–251			220–187–162–190–				
230		3	238,3	180–186–173	7	185,4	10	201,3
235–244								
240		0	—	240	1	240,0	1	240,0
245–254	331	1	331,0		0		1	331,0
250								

plusieurs auteurs, au premier rang desquels on doit placer F. Frade.

Ces études, après un long arrêt, ont recommencé cette année, dans le but mentionné ci-dessus et encore pour approfondir nos connaissances sur la biologie et sur les possibilités de pêche de ces poissons. Du point de vue biolgique nous avons jusqu'ici déterminé la longeur totale (228 individus), le poids (203), la proportion des sexes (214), l'âge (27) et le stade de maturation sexuelle (7).

Il est évident que les éléments obtenus jusqu'ici sont insuffisants pour nous permettre des conclusions définitives. Ce rapport a donc la valeur d'une note préalable.

1. Poids et longueur

Les longueurs ont été mesurées en projection horizontale, en centimètres, du bout du museau jusqu'à la fourche caudale; les poids, en kilos (Tableau 17). Les chiffres mentionnés se rapportent aux thons destinés aux usines de conserves, ce qui équivaut, nous le supposons à plus de 80% de la totalité.

Ces thons sont classés au Algarve, d'une façon tout à fait imprécise, en quatre catégories, selon leur poids: «atuns», «atuarros» «albacoras» et «cachorretas». Plus généralement le nom «albacora» est donné aux thons d'autre espèce, *Neothunnus albacora* (Lowe).

L'enregistrement de la pêche en accord avec cette classification, malgré l'imprécision de celle-ci, nous a fournit quelques indications.

En effet le respectif tableau, (Tableau 17) confirme le fait reconnu depuis longtemps, que les premiers thons pêchés sont des exemplaires de grande taille, suivis jusqu'à la fin de juin, d'un mélange d'individus de dimensions très diverses. On y voit en même temps que les exemplaires plus petits, les «cachorretas» ne reviennent pas, ou plus précisement n'ont été pas pêchés.

A moins qu'il s'agisse là d'un hasard, ce cas devra être considéré dans l'étude des migrations. Les «cachorretas», mises à part, les moyennes pour les quatre mois sont successivement: 144,9; 102,5; 134,7; 123,6 kg. La différence entre le poids moyen des thons capturés pendant le mois de mai et celui des individus pêchés dans l'époque de retour représente certainement la perte de poids subie par les poissons après la ponte; ce qui devient très évident dans le Tableau 18, où sont enregistrés les poids moyens, par classes de taille, pendant les deux époques. Pour toutes les classes à l'exception de la classe de 130 cm (seulement 3 exemplaires) le poids moyen des thons de course est toujours supérieur à celui des thons de retour.

Tableau 19. Poids perdus par les thons pendant la phase finale de la reproduction

Longueur, cm	Mâles, %	Femelles, %	Totalité, %
150	7,7	—	24,8
160	—	22,0	17,7
180	9,6	22,7	12,8
190	10,9	21,2	16,1
200	—	19,4	18,6
210	8,4	23,1	18,8
220	8,3	—	15,9
230	—	—	22,2

Note – Dans la totalité sont inclus 15 individus dont le sexe n'a pas été déterminé.

En supprimant les classes qui ne sont représentées que par 1 ou 2 individus, soit de l'époque de course, soit de l'époque de retour, les différences de poids entre les mêmes classes des deux époques, exprimées en pourcentage du poids des thons de l'époque de course (Tableau 19) nous indiquent que la perte de poids des mâles (7,7 à 10,9%) a été nettement inférieure à celle des femelles (entre 19,4 et 23,1%). L'irrégularité de la série de pourcentage concernant la totalité des individus est probablement due au mélange et à l'inégalité numérique des représentants des diverses classes de taille.

Tableau 20. Dénombrement des anneaux des vertèbres de *Thunnus thynnus* L.

Données individuelles			Données par classe de longeur		
Exemplaire, nombre	Longueur, cm	Nombre d'anneaux	Longueur, cm	Nombre d'individus	Moyenne d'anneaux
104	137	6			
121	140	6	140	2	6
83	146	6			
82	147	7			
102	150	6			
228	150	6	150	4	6,25
103	159	6			
224	160	7			
101	164	7	160	3	6,67
100	173	7			
116	174	8			
120	174	7	170	3	7,33
98	184	8			
164	184	8	180	2	8,0
99	188	8			
1	190	9			
81	194	9	190	3	8,67
118	195	8			
119	196	9			
96	198	9			
115	200	9			
117	203	9	200	5	8,8
2	215	10	220	1	10
161	227	12			
152	228	12	230	2	12

2. Taille et âge

Cherchant déterminer l'âge probable des thons observés nous avons fait le dénombrement d'anneaux chez les vertèbres de 27 individus appartenant à des diverses classes de longueur.

Parmi ceux-ci il y avait 2 seulement dont'il n'était pas possible distinguer le nombre d'anneaux. Le dénombrement a été fait au moyen d'observation directe des vertèbres, après noircissement au crayon.

Les résultats, résumés, dans le Tableau 20, nous mènent à admettre que l'âge des thons appartenant à des classes comprises entre 140 et 230 cm (le plus petit avec 137 cm; le plus grand avec 228 cm), varie entre 6 et 12 années. Ces résultats ne diffèrent pas beaucoup de l'échelle de SELLA pour les thons de la Méditerranée.

3. Proportion des sexes

La détermination du sexe des 214 individus a démontré la supériorité numérique des femelles sur les mâles, pendant toute la période, et les pourcentages ont été à peu près les mêmes, soit considérant les thons de course, soit ceux de retour (Tableau 21).

Tableau 21. Proportion des sexes

Sexe	Mai–juin		Juillet–août		Total	
	Nombre	%	Nombre	%	Nombre	%
Femelles .	89	63,12	47	64,38	136	63,55
Mâles ...	52	36,80	26	35,62	78	36,45
Total ...	141	100,00	73	100,00	214	100,00

4. Maturation sexuelle

Nous avons seulement considéré, jusqu'à maintenant des gonades femelles: 4 ovaires appartenant à des thons de course; 3 à des thons de retour, qui ont été étudiés au point de vue histologique. On peut résumer ainsi les résultats obtenus:—

A. Thons de course

Les quatre ovaires présentaient des aspects histologiques très semblables. Dans les préparations, colorées au Hemalun-éosine, après fixation au formol à 10%, on voyait:—

(1) un grand nombre de petits ovocytes à cytoplasme très basophyle, dans un stade de repos ou d'initiation de l'évolution maturative (diamètres entre 30 et 70 μ);

(2) d'autres ovocytes plus développés, et moins nombreux, dont le cytoplasme, finement granuleux, révélait déjà un légère tendance à fixer l'éosine et présentait une couronne régulière de petits vacuoles disposés autour du nucleus (diamètres entre 100 et 200 μ);

(3) des ovocytes plus évolués (300 à 360 μ) au cytoplasme éosinophyle et granuleux, dont les vacuoles périnucléaires présentaient une grande hétérogénéité de dimensions; généralement plus grands que ceux des ovocytes antérieurement cités;

(4) ovocytes presque mûrs (400 à 460 μ), présentant des gouttes vitellines parfaitement individualisées et, dans la région centrale, une aglomération de nombreux vacuoles, généralement de grandes dimensions (400 et 460 μ);

(5) ovules mûrs, très rares. On ne voyait plus les vacuoles, le cytoplasme se présentait complètement rempli de gouttes vitellines de diverses dimensions. Cellules folliculaires très aplaties (500 μ, à peu près).

De tout le matériel cité on a fait des coupes par congélation, colorées au Sudan III/Hemalun. Ces préparations ont révélé la nature lipidique des vacuoles ainsi que l'évolution maturative des ovocytes en fonction de la densité de coloration par le Sudan, au fur et à mesure que la maturation était plus avancée. Les aspects vérifiés nous mènent à conclure que les poissons se trouvaient dans un stade de maturation sexuelle voisin de la ponte. Le nombre d'ovules mûrs qu'on a observé était remarquablement petit. La sériation maturative des diverses classes d'ovocytes en diverses phases de leur évolution nous permet la conclusion, d'ailleurs déjà connue. que la ponte de ces thons est fractionnée.

B. Thons de retour

Les trois ovaires étudiés montraient des remarquables différences dans leur aspect histologique; il n'y avait donc pas la presque uniformité constatée chez les ovaires des thons de course.

Les ovocytes tout à fait semblables à ceux des groupes 1 et 2 déjà cités se disposent irrégulièrement sur les lamelles conjonctives de l'ovaire, la plupart présentant des signes bien marqués de nécrose massive avec pulvérisation du contenu cellulaire.

On voyait quelques follicules vides et d'autres, totalement ou partiellement, remplis par des amas de cellules aux noyaux arrondis. On ne voyait plus d'ovocytes très developpés, ni d'ovules mûrs. Les seules cellules qui présentaient des signes de vitalité, révélés par leur structure intacte, étaient des petits ovocytes (diamètres 10 à 30 μ), à cytoplasme très basophyle, réunis en des nids parsemés formés certainement après la ponte, puisque ils ne se trouvaient pas dans les préparations des thons de course. Nous ne pouvons pas nous prononcer sur leur origine mais nous admettons qu'ils constituent la base cytologique de récupération ovarienne pour de nouvelles et futures périodes de réproduction.

H. VILELA et Collaborateurs

Salmon and Trout

England and Wales

River Axe Salmon Investigation

Construction of the salmon trap in the river Axe has proved to be a much longer job than was anticipated, but the installation was brought to the state where it could be operated on 1. December 1958, and was immediately fished through a medium flood. Within two days one fresh-run salmon, one fresh-run sea trout, and 15 sea-trout kelts had been taken in the upstream migrant trap and 340 kelts and whitling in the downstream migrant trap. Of the 340, only six were salmon, the remainder being sea trout. The 15 sea-trout kelts taken in the upstream migrant trap had been released from the downstream migrant trap only a short time before, to continue their journey to the sea. Six brown trout and a few eels were also taken on the downstream migrant trap, as well as a number of flounders.

Subsequent severe floods indicated that the structure of the installation needed to be strengthened and this is now almost completed.

I. R. H. Allan, M. J. Bulleid

Salmon and Sea Trout caught at Sea

(Table 1)

No salmon have been reported caught but reports of 38 sea trout caught by trawlers on the North Sea fishing grounds have been received this year, against 74 in 1957.

Fewer trawlers were fishing from Lowestoft, the port from which all the reports were received.

The sea trout caught may be classified as set out in Table 1.

This analysis shows that as usual the bulk of the catch consisted of fish with 2 or 3 years sea life. The great majority (81.6%) migrated as 2 year-old smolts.

None of the above fish was reported as having been tagged but a single tagged sea trout was recaptured in July by a Dutch fishing vessel in the same area. It had been tagged in the River Coquet as a smolt in 1957.

W. G. Hartley

Research on Osmoregulation in Salmon

The study of osmoregulation in salmon has continued along the lines previously reported. These were: firstly, analyses of the inorganic constituents of the blood; secondly, a study of the growth of tolerance to salinity; and thirdly, a histological study of the gills in freshwater and marine fish. A further investigation into the relationship between vitamin A in the diet and osmoregulatory ability has been started but this has been interrupted by a loss of fish stocks.

1. Composition of salmon blood

In this first line of investigation, mean figures for freezing-point depression, and levels of concentration of sodium, potassium, calcium chloride and carbonate in the blood of salmon, during its life from newly hatched egg to the marine or freshwater adult have been obtained. The blood changes very little during the freshwater life of the young salmon, but there are quite marked changes in the blood when the smolt migrates into sea water. The freezing-point depression of the blood increases by

Table 1

Smolt age	Post-smolt age (years and class)								
	1			2	3		4	5	6
	0+	1+	2+	1 + SM +	2 + SM +	1 + 2 SM +	1 + 3 SM +	1 + 4 SM +	1 + 5 SM +
2 years	1	3	2	11	1	9	2	1	1
3 years	1	1	0	2	0	3	0	0	0

about 15% but the sodium and chloride concentrations do not increase to quite the same extent. Thus it appears that some other ions (since potassium is not present in osmotically significant amounts) are making up the balance of ions. Analyses of two further inorganic constituents, calcium and carbonate, are being made, and also of a nitrogenous base, trimethylamine and its oxide, to see if these substances contribute to the adaptation of the fish in sea water. These analyses are not yet complete. Trimethylamine does not seem to be present in the blood in detectable quantities, although estimates of its concentration in the muscle have been obtained for adult fish in sea water, and for smolts in fresh water.

2. Development of salinity tolerance

Some further experiments have been made on salmon and trout of different ages. These tests now cover the life history from newly hatched alevins to seaward migrating smolts. Tolerance to high salinities is great in newly hatched alevins, drops off sharply to a minimum at about the time the yolk-sac is absorbed, and then builds up gradually as the fish grows. The development during growth of tolerance and the osmoregulatory ability which accompanies it, could be the result of one or more factors: —

(a) Increase in size, and thus a more favourable surface volume ratio.

(b) Increase in the impermeability of the skin.

(c) Development of special mechanisms for osmoregulation, e.g. acidophil cells in the gills.

3. Histological study of the gills

Following the development of a suitable technique for identifying the acidophil ("chloride-secretory") cells in the gills of teleosts, a collection has been made of histological material from the gills of salmon and trout at many points in their life histories. The acidophil cells do not seem to be present in the gill rudiments of the newly hatched alevins, and are difficult to find in young fry of a few months old; in the young parr and smolt there are usually one or two acidophil cells between each pair of gill lamellae; in the adult, sea-living fish, there are usually 6—8 of these cells between the lamellae. Whether this increase in number represents a real increase per unit weight of fish is not known. No accurate means of assessing the numbers of the acidophil cells has been devised.

An investigation of other parts of the buccal and branchial cavities in fish, showed that the greatest development of these cells is in the pseudobranch. Ion-exchange is unlikely to occur in this organ, because of its anatomical relationships, and this leads one to ask if the similar cells in the gills do, in fact, perform the function of salt excretion or absorption.

4. Vitamin A in salmon

A survey of the relative amounts of the two isomers of vitamin A in the organs of salmon of different ages (and in fresh water and sea water) is being prepared in collaboration with Dr. L. R. Fisher and Dr. S. Kon of Shinfield, Reading. Both isomers are present in parr and smolts artificially reared in fresh water, and also in smolts naturally grown. Analyses for adult sea-living fish are not yet available; and those for adult freshwater spawning fish are awaiting the collection of material. Little progress can be reported for the experimental feeding of young fish on a vitamin A deficient diet, and one containing only vitamin A_2. Some fish (parr) were kept healthy for 8 months on a vitamin A free diet. After 5 months of this diet, however, the fish still contained good reserves of vitamin A.

Gwyneth Parry

Germany

Salmon Landings

(Figure 1; Tables 2–3)

After a continual increase of the yield of the German salmon fishery in the south-eastern part of the Baltic to 345 tons in 1957, the landings diminished to 194 tons in 1958. In the second half of January and in February, poor catches were obtained due to heavy storm and ice. The landings remained low, and only by early employment of drift-nets already in March, the yield could be maintained at a nearly constant level until the beginning of June when the season finished. When the fishery was taken up again at the end of October, good catches were made and the last two months brought 56% of the annual yield. In spite of the decline, the total catch in 1958 was larger than the average for the period 1949/58 (170 tons).

As the German salmon fishery is stopped in summer time (June/September), it is recommendable for comparison to consider the total catch in the fishing season lasting from October to May. In this time the stock of salmon does not change very much in regard to size and age composition, as the main growth and spawning migration take place from spring to autumn. Until 1956, the total catch of the fishing season varied between 75 and 196 tons, with an average of 134 tons. In the fishing

season 1956/57 the yield suddenly rose to 375 tons, against 140 tons in the previous season. In the following season 1957/58 the catch was still considerably above the average, amounting to 241 tons, and a similar result is to be expected in 1958/59.

The size composition of the landings at the Kiel fish market in 1958 is given below.

Size composition of salmon catches in 1958

Market category	I	II	III	IV	V
Gutted weight, kg	>8	5–8	3–5	2–3	<2
	Number (%)				
January/February	13.2	24.6	25.0	30.0	7.2
March/April	18.8	28.4	38.9	13.0	0.9
May/June	15.2	23.3	38.4	22.3	0.8
October/December	5.0	21.8	52.5	19.3	1.4
Total catch	9.4	23.4	43.5	21.0	2.7

As in the preceding years, the size composition of the catches changed in the course of the year 1958, especially from spring to autumn, in consequence of the fluctuations in the stock of salmon. The proportion of large salmon (category I) was relatively high in the first months of the year, and decreased heavily in the latest months, whereas the fish of medium size (category III) increased remarkably. This indicates a partial renewal of the stock resulting in a considerable decrease of the average weight, from 5.18 kg in spring to 4.22 kg in autumn.

In 1956 a similar decrease of the weight was observed, whereas in 1957 the average weight increased, from 3.75 kg in spring to 4.88 kg in autumn. Although these differences in size are partly balanced, if we consider the mean weight for each year, a remarkable rise in 1958 is evident, as will be seen from the following figures: 1956, 4.03 kg; 1957, 4.16 kg; 1958, 4.51 kg.

There is a close connexion between different features of a fishing season which are shown in Table 2.

In the five fishing seasons under consideration we observe an alternation of higher and lower average weight of salmon. Where the average weight is high there is a decrease in the catch per trip and total landing and, correspondingly, with a lower weight the catch increases. These changes are caused by the entry, growth, and decline of a rich year-class.

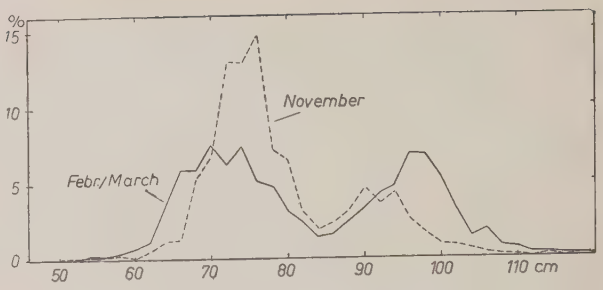

Figure 1. Length distribution of salmon caught by drift-lines in the south-eastern Baltic, February/March and November 1958.

This phenomenon has been studied by Fr. Thurow for the rich 1953 year-class, the majority of which had entered the sea after having spent two years in the river. In their second winter in the sea (2.1 + years old) they constituted a considerable proportion of the large catch in the season 1956/57 (about 40% in number). In the following season 1957/58 about half of the salmon caught belonged to this year-class (2.2+ and 3.1+ years old). For the present season 1958/59 we can assume that the large fish of the 1953 year-class (2.3+ and 3.2+ years old) still contribute considerably to the catch.

In the last report (Ann. Biol., 14: 210), the change in length distribution of the commercial catches in the course of the year was shown in a diagram. The same phenomenon in 1958 will be seen from Figure 1 which shows that the change in the size composition was contrary to that of the preceding year. The height of the two peaks in the length curve representing the salmon in their second and third winter, varies in a distinct manner depending on the relation between the strength of these year-classes. In the first months of 1958 they were nearly equally represented, but at the end of the year the entry of a new fishable year-class, probably 2.1+ year-old fish, i.e., the 1955 year-class, caused a considerable rise of the first peak and a lowering of the second one. Obviously the 1954 year-class which became fishable in the autumn 1957 at the same age, was less frequent than the preceding rich 1953 year-class, because they were nearly equally represented in the catches.

Table 2. Total landings, mean catch per trip, and average weight of fish in the German salmon fishery

Fishing season	1954/55	1955/56	1956/57	1957/58	1958/59
Total landings, tons	195	140	375	241	267
Catch per trip, kg	604	445	885	568	698
Mean weight (gutted), kg	4.38	5.33	4.02	4.85	4.27

Table 3 shows the quantities of each market category landed at the Kiel fish market during the last two years.

Table 3. Salmon landed at the Kiel fish market in 1957 and 1958 (in tons)

Market category	I	II	III	IV	V	Total
Jan./June 1957	14.6	37.9	45.0	38.1	3.9	139.5
Oct./Dec. 1957	24.1	51.4	14.7	12.8	2.6	105.6
Jan./June 1958	19.1	23.2	16.0	8.0	1.0	67.3
Oct./Dec. 1958	8.3	26.2	35.4	9.4	0.4	79.7

The landings of each market category vary according to the growth of the fish and the fluctuation in the smolt production. In the course of 1957 the maximum landing shifted from market category III to II, and in the last months of 1958 again back to III. The quantities of market categories I and II landed in October/December 1958 are less than half of those in 1957, whereas III and IV together have increased by more than 50%. These facts must not be regarded as a symptom of overfishing.

R. Kändler

Scotland

The census of migrating salmon in the Conon River System (Ross-shire) has been continued through the year. A count of all ascending and descending migrants has been made at the Meig and Luichart traps. The latter was out of commission until mid-March but this circumstance did not affect the accuracy of the counts as during this period no movements of fish were likely to occur at the trap site. At the Meig trap just over 9,000 smolts migrated downstream and the count of ascending adults totalled 256. Both totals were less than those for 1957, when the corresponding figures were approximately 14,000 and 600. At the Luichart trap nearly 2,000 smolts passed downstream and 73 adults had entered the trap. The total of adult fish is again less than that for 1957 but the number of smolts shows a substantial increase. There is evidence, however, that part of the smolts which passed through the Luichart trap had come from the Meig, by means of the tunnel connecting the two rivers.

Further observations have been made on the efficiency of the pass systems on the Conon River system by adding marked smolts at various points above the two pass systems involved, at the Meig and Luichart dams. One result of these tests was to show that smolts could pass from the Meig impoundment to the Luichart impoundment. A defect in the screens at the entrance to the tunnel between the two impoundments has since been found; this will be rectified before the smolt migration in 1959.

Because the number of smolts passing through the Luichart trap has been very small in comparison with the fry plantings upstream (which are the sole source of smolts, since natural spawning is not yet possible in this branch of the Conon system) a survey was started, during the summer of 1958, to determine the reasons for this unusually heavy mortality. Some interesting results were obtained, but these can only be regarded as preliminary in character as the survey was only in progress for part of the year.

The two traps on the burns entering Lui Water (River Dee, Aberdeenshire) have been in operation throughout the year and the results obtained confirm the preliminary indications found in 1957, that a large proportion of the alevins which hatch in the spring die during their first summer. Results in 1958 showed that in one burn, over 90% of the alevins had died before August; in the other burn the mortality was 70%. A number of observations were made on the characteristics of the migration of the fry and on their food, growth, and scale development.

During the year ended 30. September 1958, 125 fish were received for examination in connexion with the statutory diagnostic service for furunculosis .Most of the fish received were salmon, sea trout, and brown trout; 15 (11 salmon, 3 sea trout, and 1 brown trout) were found to be suffering from furunculosis and 31 (30 salmon and 1 sea trout) from Dee disease. One salmon was suffering from Dee disease and furunculosis. No epidemics of furunculosis were reported but a number of cases of this disease occurred among salmon which had been impounded. Observations during the late autumn and early winter showed that a high proportion of the fish in samples of kelts from some east coast rivers were suffering from furunculosis.

An organism was isolated in salmon from the River Dee which seems to be the cause of Dee disease. This organism has been injected into brown trout and salmon parr and has proved to be pathogenic; in nearly half the cases the organism has been re-isolated after death. It has not yet been possible to inject this organism into salmon.

Further observations on the homing behaviour of young trout have shown that fish 1+ years old will return to their natural stream when transferred elsewhere. One of the streams entering Dunalastair Reservoir burst its banks during the autumn of

1957 and when the channel was dug out again early in 1958, the opportunity was taken to test the theories which had been developed about modifying streams in such a way that fisheries interests are safeguarded without reducing drainage efficiency. The method adopted is to leave heaps of gravel at intervals along the bed of the stream instead of digging out the latter to produce a uniform gradient. In the particular case tested, the modification increased the area available for redd formation considerably and it was satisfactory to find that the new configuration of the bed was stable, in spite of heavy floods during the summer months.

The study of the growth of trout in tanks in the laboratory has been continued and results are now available for three years. Comparisons can now be made between the growth occurring during mild and severe winters and it seems that a small rise in temperature, when water temperatures are low, can cause a marked increase in feeding activity. Further observations on the trout in Loch Garry (which had been increased in size following hydro-electric developments) showed that these fish had continued to grow at an increased rate during the summer of 1958 and that, as in 1957, aquatic organisms formed the bulk of their food. During the first two years after the flooding of Loch Garry it was found that the fish which were immature throughout the period showed the greatest increases in length, whereas those which spawned twice showed the smallest length increments. More general studies of growth and maturity in trout are also being made and these are being extended into a study of the factors affecting the growth of trout in lochs of widely different characteristics.

Observations have been continued on the growth-rates of trout in lochs which have been treated with mineral fertilizers. In the lochs in the Scourie area (West Sutherland) (which were fertilized in 1954 and 1955) the increased growth-rates were maintained during 1957 but preliminary indications suggest that growth-rates may have been less during 1958.

Further studies have been made on the factors affecting the emergence of aquatic insects and during 1958 particular attention was paid to comparisons of the efficiency of various types of trap. Observations have also been continued on the rate of colonisation with bottom fauna of a small hill loch and further assessments have been made of the bottom fauna of the lochs in the Scourie area which have been treated with mineral fertilizers. Again there are signs that the effects of the treatment are beginning to decrease.

Work undertaken by the chemical section has mainly been concerned with further observations on the chemistry of lochs treated with mineral fertilizers, the phosphate content of bottom deposits and the inter-relationship between phosphate dissolved in the water and present in the bottom deposits and the phosphorus content of macrophytes. A number of smaller projects, such as the investigation of methods for the determination of traces of cyanide in fish tissues and tests of the efficiency of commercial weed-killers, have also been investigated.

K. A. Pyefinch

Soviet Union

Northern Salmon

(Tables 4–6)

The total catch of salmon in the Murmansk district and in the White Sea is given in Table 4.

In 1958, in the Kola peninsula, investigations were continued in order to calculate the coefficients of return of adult salmon from a known number of spawners, the total survival (percentage of the approximately known number of eggs in spawning females), and survival until repeated migrations.

In 1958 the return of the broods from the spawning in 1950 was completed. When considering that the mean coefficient of salmon return in the River Tuloma at present is 1:3.9 and in the River Kolvitsa 1:4.0 the results of reproduction of the broods from 1950 may be regarded as satisfactory.

Table 4.

	Murmansk district								
Year	1950	1951	1952	1953	1954	1955	1956	1957	1958
Cwt	3,907	3,287	4,256	4,558	5,958	4,087	2,630	2,509	3,147
	White Sea (Karelian coast)								
Cwt	216	257	130	202	261	182	192	133	—

Table 5.

River	Number produced in 1950	Number of returned adult fish 3 +	4 +	5 +	6 +	7 +	Total	Coefficient of return
Tuloma	1920	514	1,705	2,619	789	364	5,991	1 : 3.1
Kolvitsa	260	516	272	502	33	4	1,527	1 : 5.0

Table 6.

Date of tagging	Date and place of recapture	Number of days at liberty
19. June	19. July, Estuary of the White Sea	30
19. June	15. October, River Varzuga	117
19. June	18. October, in the mouth of the River Varzuga	121
19. June	1. November, in the mouth of the River Varzuga	135

In order to determine the number of salmon which return to the River Varzuga for repeated spawning a tagging experiment was carried out in 1958 on salmon kelts, i.e., the spawners returning from their spawning grounds in the sea. In June, 31 kelts (29 females and 2 males) were caught near the River Varzuga. They were tagged with celluloid tags fastened with non-corrosive wire of 0.4 mm diameter to the prerigofores before the dorsal fin.

Up to 15. December 1958, 4 tags were returned by fishermen.

Previous investigations by Azbelev and Lagunov based on taggings carried out in 1951 and scale reading show that the Varzuga salmon return mainly for repeated spawning after one summer spent in the sea. This observation was confirmed by scale readings during the period 1954/1957.

Salmon taggings carried out in 1953 confirmed also that salmon return for repeated spawning in the year of migration from the river.

As regards the number of tagged salmon three specimens which returned to the River Varzuga constituted 9.7%. Only one fish was caught in the estuary of the White Sea, underway to the feeding grounds. The proportion of fish returning for repeated spawning was in good agreement with our previous investigations. There is thus evidence for believing that the number of kelts returning for repeated spawning is rather constant in proportion to the number of kelts tagged.

I. I. Lagunov
V. V. Azbelev
M. N. Melnikova

Shellfish

CRUSTACEA

Investigations on the German Shrimp Fishery in 1958

In 1958 the Institute of Coastal and Freshwater Fisheries continued its researches which commenced in 1954, on the composition of shrimp catches. These investigations were necessitated by the North Sea Convention of 1946 in order to determine the proportion of undersized, protected fishes taken together with the shrimp catches. It was thought desirable to extend the investigations over several years since the shrimp fishery fluctuates to a great extent from season to season, in accordance with the fluctuations of the water temperatures.

It was expected in 1958 that the unusual cold spring would furnish further information regarding the influence of the water temperature upon the shrimp fishery. Owing to the cold spring the fishery started late, the catches increased, however, considerably during the autumn, although the total landings did not reach the size of previous years. The landings of past years were as follows:—

1958 — 28,348 metric tons	1956 — 32,889 metric tons
1957 — 34,848 metric tons	1955 — 42,922 metric tons

Considerable differences occur between the years as to the seasonal distribution of the catches. In 1958 only 40.6% of the total catch were landed up to the end of August, whereas 60.0% and 64.9% respectively were landed up to this date in 1957 and 1956. In 1955, however, this percentage was only a little higher than in 1958, being 45.2%.

In 1958, 511 random samples of unsorted catches were analysed as to composition. The length composition of shrimps was determined in 261 samples in order to follow up the seasonal changes in the catches.

The proportion of undersized, protected fish, i. e., plaice, dab, sole, whiting, and cod contained in the catches was on an average far below 10% in nearly all months. It is insignificant that this percentage was a little higher than 10% in Niedersachsen, in December, since the catches in this month were less than 2% of the annual German landings. The amount of undersized plaice and dab destroyed by the German shrimp fishery was similar to that of 1957, whereas more soles were destroyed in 1958 than in 1957. Undersized whiting and cod were much less abundant than in the previous year, so much so that both species were hardly present in the samples.

It is obvious that the change in the number of protected fish contained in the shrimp catches depends widely on the size of the stocks of young fish that enter the fishery. On the other hand, the yearly fluctuations in the abundance of the progeny of these fish species can be recorded by the shrimp fishery.

Research on the selectivity of sieves of different bar-width was continued. It was discovered that the selectivity does not only depend on the size of the shrimps but also on whether or not the shrimps are berried. Small shrimps bearing eggs between their swimmerets are to a greater extent retained in the sieve than those which have no eggs.

P. F. Meyer-Waarden

Reference

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MOLLUSCA

Oyster

Larvae and Spatfall of Oysters in the Oosterschelde (Netherlands) in 1958

(Figure 1)

Spatfall prediction is especially valuable for oystermen using tile collectors. The scattering of mussel shells as collectors, practised on a large scale in the Netherlands, allows a wider range of time. Even if scattered one or two weeks ahead of the main maximum in setting, the shells may yield good results. Moreover the shells, being cheap and requiring little manual labour, need not necessarily be used with the same degree of efficiency the tiles demand in a remunerative culture. The ever increasing stock of oysters in the Oosterschelde, due to several years of good and even excellent setting on tiles and shells, leads to a decreasing demand for

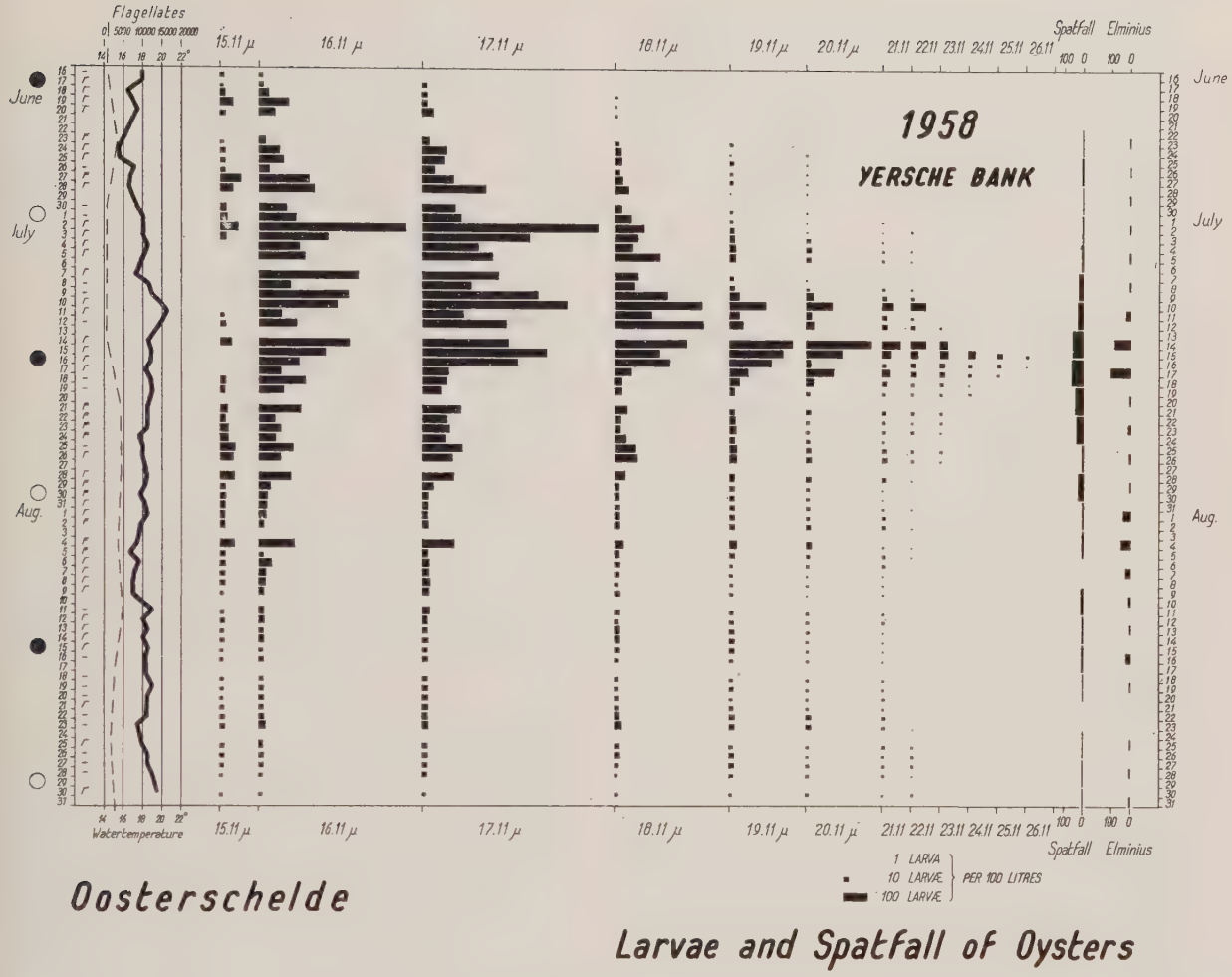

Figure 1.

young oysters. Hence, the more expensive collectors, the lime-coated tiles, are lately placed in decreasing numbers. The number of tiles is, however, still important enough to warrant continuation of spatfall prediction.

The methods used in collecting samples of 100 litres of water and in counting and measuring the larvae in such samples have been described previously. The samples were again collected at the Yersche Bank station, in the centre of the Basin of the Oosterschelde. Daily samples were taken at high slack water from 16. June up to 26. June inclusive; twice-daily samples, at high slack water and low slack water, in the height of the season from 27. June to 8. August inclusive. From 9. to 30. August samples have been collected at high slack water only. It was impossible to collect plankton samples on Sundays when the boats stayed in port. When two samples were taken a day, the average number of larvae of each size class has been computed for 100 litres, and is depicted in the diagram (Fig. 1). The intensity of setting was measured in the usual way by exposing 3 lime-coated glass slides, measuring 13 x 18 cm, at an angle of 45° in a concrete container for periods of 3 days. The average number of spat per slide is shown in the diagram. The average number of barnacles (predominantly *Elminius*) found on 10 cm² of the slides (5 cm² upper plus 5 cm² lower surface) has also been depicted in the diagram.

Again it was predicted that the total number of larvae to be produced would be so great that only adverse conditions would lead to disappointing practical results. Huge numbers of larvae were expected to appear late in June already, so that, under otherwise favourable conditions, setting of commercial magnitude could be anticipated in the second week of July.

Spring was unusually cold in the year 1958. Though water temperatures in January and February were slightly above the average, March was 1.2°C below the average, April even 1.5°, and May 0.2°. The first part of June was 0.2° too cold, the second half 0.5°. Still, it could be stated from experience that the appearance of the oyster larvae would not be delayed by the cold spring.

The first bulletin, issued 19. June, stated that the first few oyster larvae had made their appearance, but that the water temperature was unfavourable for their development, as it had not yet attained the 18°C level. On 23. June the number of oyster larvae per 100 litres of water was said to be still less than 100. On 26. June it was stated that neither the number of larvae nor the temperature of the water showed an increment worth mentioning. A rapid increase in the number of oyster larvae to over 500 per 100 litres was recorded in the bulletin issued on 1. July. Water temperature still being rather low, growth of the larvae was said to be slow, so that setting of any importance could not yet be announced. On 4. July it was stated that the number of oyster larvae remained above the figure 500 and that the water temperature, having attained the 18°C level, made possible a slow development of the larvae. On 10. July the number of larvae was given as over 1000 per 100 litres of water. Fine weather led to higher water temperatures and thus to better larval development. Setting of some importance was announced. On 17. July the outlook for spatfall was characterized as very favourable, the number of larvae still being over 1000 and the number of "umbo" larvae having gone up by leaps and bounds. A decline in water temperature, in the total number of larvae, and in the number of "umbo" larvae led to considerably less favourable setting indications on 22. July; and in the bulletins broadcast on 30. July and 15. August setting prospects were said to be insignificant.

The diagram (Fig. 1) demonstrates that the total production of larvae has been great, though falling short of that in the years 1957 and 1956. The size of the stock of oysters cannot be held responsible for this difference; the decline is not ascribed to the slightly leaner condition of the oysters in the season 1957/1958 as compared with the previous season, but to the unusually cold spring, which gave the oysters little opportunity to recuperate prior to spawning. The number of larvae produced per oyster must have been smaller than the year before.

The diagram reveals also that the vast majority of the larvae made their appearance between 28. June and 16. July, and that the numbers of larvae liberated in August were very much smaller than in the year 1957.

With exception of the mid-July period, larval development was not very good. This is partly ascribed to the rather low water temperatures, partly to the low level of the flagellate population. These food organisms for oyster larvae numbered less than 5,000 per cm^3, often even considerably less, whereas figures above that level were found in the preceding years. Though it may be the quality rather than the quantity of flagellates which counts in larval development, the low and very low figures recorded in the summer of 1958 give reason for concern.

Setting on lime-coated glass collectors commenced as early as 22. June, despite low water temperatures and such small numbers of larvae in the larger size classes that they escaped attention. It was not before 6. July that the setting intensity became commercially important, and the large majority of spat settled between 12. and 24. July. This all tallies very well with the forecasts. Some oyster spat settled throughout August, despite the small numbers of larvae and the obvious rareness of "umbo" larvae. In the plankton samples "umbo" larvae, measuring from 250 μ upwards, were only encountered in the mid-July period, this in contrast to previous years, which always showed more prolonged periods with "umbo" larvae. Setting figures demonstrate that even in case less than one "umbo" larva occurs per 100 litres of water this may result in a measurable spatfall intensity with the methods used.

Commercially the spatfall season was successful in the year 1958. Both the lime-coated tiles and the mussel shells scattered on the deeper plots caught a good set of spat.

Again the setting of barnacles showed a peak coinciding with the best oyster setting, followed by a peak of secondary importance early in August.

P. Korringa

The Quality of Oysters in Relation to Environmental Conditions in the Oosterschelde in 1958

(Figures 2–22)

The investigations on growth and fattening of oysters in the Oosterschelde (Netherlands) were continued in 1958. Again, considerable attention was paid to the factors which are presumably associated with the oyster's feeding conditions. Hydrographical, meteorological, chemical, and biological observations were made throughout the year, whereas determinations of the quality of the oysters were confined to the second part of the year.

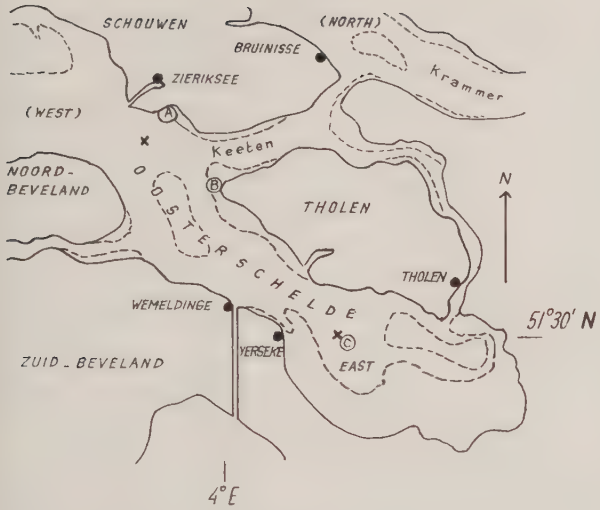

Figure 2. Water sampling stations and the plots for which fluctuations in the quality of the oysters have been determined. A cross denotes stations of water sampling at Zieriksee (western district) and Yerseke (eastern district). The open circles denote plots of oyster sampling: (A), O.S.W.D. 11/12; (B), O.S.W.D. 36; and (C), Y. Bank 339 (O.S.E.D.).

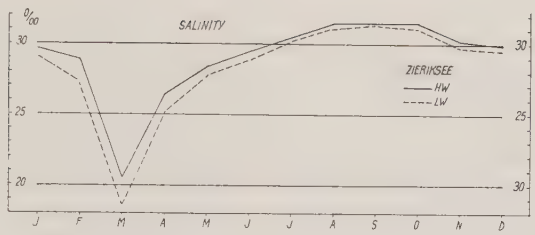

Figure 3. Salinity at Zieriksee.

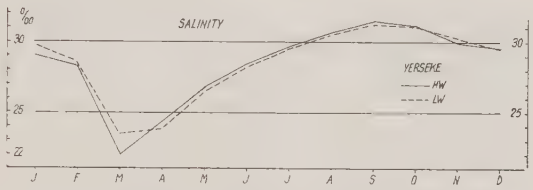

Figure 4. Salinity at Yerseke.

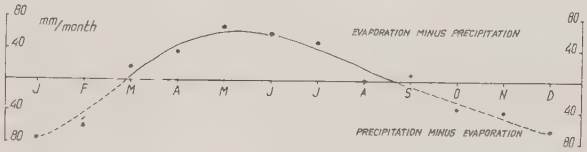

Figure 5. Evaporation and precipitation.

Samples of water and of oysters have been collected both in the western and in the eastern section of the Oosterschelde, so far as feasible on a weekly basis. The water sampling stations and the plots for which the weekly fluctuations in the quality of the oysters have been determined, are given in Figure 2. Both plot A and plot B are situated in rather shallow, sheltered water, in proximity to the sea-dikes of the isles of Schouwen and Tholen, not far from the water sampling station Zieriksee. Oyster plot C, on the other hand, is situated on the Yerseke Bank, in the eastern district, due east of the oyster town Yerseke.

Water samples have been collected a little below the surface, both at high slack (H.W.) and at low slack (L.W.) water, on one and the same day.

Salinity

A remarkable feature was the sharp drop in salinity in early spring, brought about by discharge of unusually large volumes of fresh water by the rivers Rhine and Meuse. This influx of fresh water came from the north and penetrated into the Oosterschelde via the Keeten. Therefore the drop was sharper and came somewhat earlier in the western district (Zieriksee, Fig. 3) than in the eastern section of the Oosterschelde (Yerseke, Fig. 4). The rather considerable differences between H.W. and L.W. salinities in the station Zieriksee in the first quarter of the year can be ascribed to this influx of fresh water from the north. The return of normal salinity conditions also took place from west to east: in the station Yerseke the rise in salinity came later than at Zieriksee, and it was the H.W. samples at Yerseke which were leading in this respect.

The sharp drop in salinity did not lead to noteworthy losses among the oysters in the Oosterschelde, partly because water temperatures were still low at that time. In the district north of the isles of Schouwen and Tholen, however, one did observe a somewhat higher mortality rate, but salinities have been lower here, and for a longer time, than in the Oosterschelde. On many Oosterschelde plots the cupped valves of quite a large percentage of the oysters showed water-filled "chambers" later in the year. This is no doubt correlated with the rapid rise in salinity after the sharp drop in spring, leading to shrinkage of the oyster's tissues, and forcing the oysters to make a "chamber".

That the salinity in the Oosterschelde is not directly correlated with the local precipitation and

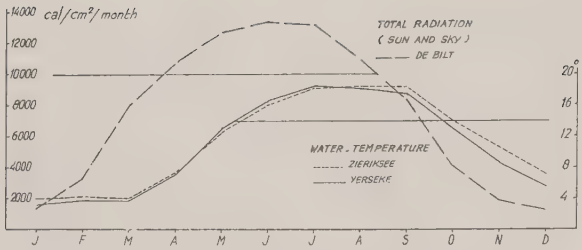

Figure 6. Total radiation and water temperature.

evaporation, but is largely governed by the discharge of river water, can be derived from the data given in Figure 5, based on observations of a nearby meteorological station.

Temperature

Water temperature followed the usual pattern (Fig. 6). Again, the rise in temperature came somewhat earlier in the eastern than in the western district, but the same held good for the drop in temperature in autumn. This can easily be ascribed to the relative shallowness of the eastern basin, which is therefore bound to follow weather conditions more closely than the water of the deeper western district.

The rise in temperature was somewhat overdue, for spring was cold, but fortunately the water remained rather warm in September, so that recuperation of the oysters after the spawning season could go on for quite a while.

Since the sun's radiation is closely associated with fluctuations in water temperature, a graph is added (Fig. 6) giving radiation data collected in the headquarters of the Royal Netherlands Meteorological Institute at De Bilt. Though the observations were made some 100 km from the Oosterschelde, we may rest assured that the general trend will hold good for this area too, though minor deviations will have occurred. The peak of solar radiation was reached in June and July with some 13,000 cal./cm². This stands in sharp contrast with the winter months yielding values under 2,000 cal./cm². Since light is such a very important factor in phytoplankton development, it is interesting to have these radiation data at our disposal.

Phytoplankton

The phytoplankton data for the year 1958 are presented in Figures 7 (Zieriksee) and 8 (Yerseke), again expressed in mg of chlorophyll per m³. Besides data on the *total plankton* the graphs give quantitative information on the following fractions: *net plankton*, measuring over 55 μ, the *larger nano-*

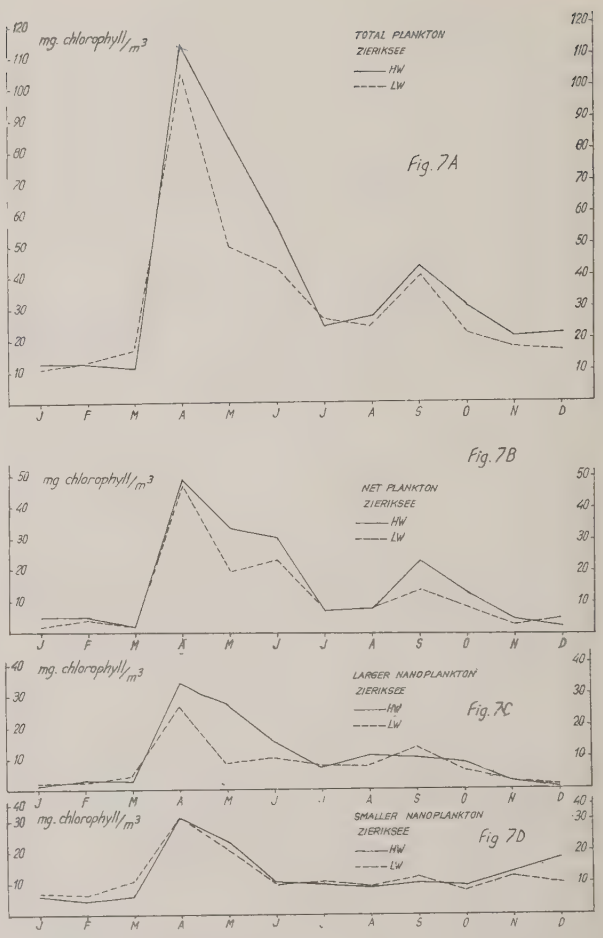

Figure 7. Zieriksee. (A) total plankton; (B) net plankton; (C) larger nanoplankton; (D) smaller nanoplankton.

plankton, measuring less than 55 μ but over 15 to 20 μ, and the *smaller nanoplankton*. Again, bolting silk No. 25, soft paper filters, and membrane filters have been used to separate these fractions. The suggestion has been made that the net-plankton figures may be too high, since zooplankton organisms retained by the bolting silk may have ingested many nanoplankton organisms, and that the smaller nanoplankton may contain chlorophyll pertaining to detritus whirled up from the bottom. Repeated microscopical inspection revealed, however, that these sources of error are of minor importance only.

The yearly averages for the *total chlorophyll* content amounted to 38.0 and 32.0 mg/m³ at Zieriksee H.W. and L.W., and to 28.9 and 27.7 mg/m³ at Yerseke, H.W. and L.W. respectively. Several factors can be held responsible for the diminution from west to east. Grazing by bottom

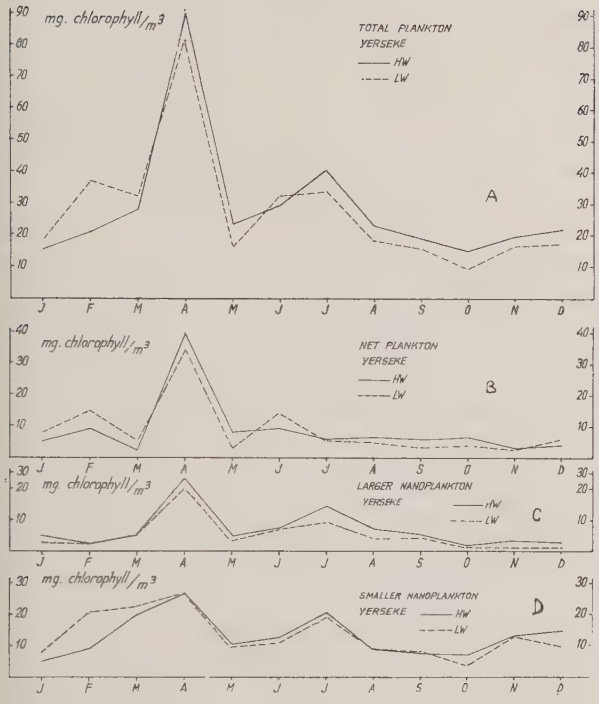

Figure 8. Yerseke. (A) total plankton; (B) net plankton; (C) larger nanoplankton; (D) smaller nanoplankton.

invertebrates will probably be of greater importance — calculated per volume of water — in the shallower eastern section. This factor would, however, involve far greater seasonal differences than can be read from the graphs. If nutrients were equally abundant in eastern and western sections, one would expect a far richer plankton development in the eastern section, because of the shallowness, allowing the light to penetrate practically to the bottom, and the considerably greater clarity of the water, working in the same direction, allowing almost all of the water to participate in phytoplankton production, this in contrast to the conditions prevailing in the deeper turbid waters in the western district. That nevertheless the western section is richer in phytoplankton points to a greater primary production there, presumably caused by a greater abundance of plant nutrients.

The station Zieriksee reveals two peaks in phytoplankton production, the first in April, very pronounced and especially in the westernmost area — shown by the H.W. samples — of long duration; and the second, of minor importance, in September. At station Yerseke too the first phytoplankton peak occurred in April, but was of shorter duration there than at Zieriksee. The second peak occurred at station Yerseke as early as June/July, and was there too of considerably less importance than that in April.

It is of great interest to note the interaction of phytoplankton development and the quantity of free phosphates (Figures 11A and 12A). The April peaks lead to an almost complete exhaustion of the free phosphates. A subsequent slight rise in the free phosphate level led to interruption of the phytoplankton decline at the Zieriksee station, and a further rise to the secondary plankton bloom in September.

The *net-plankton* figures yield an average chlorophyll content of 15.3 and 11.9 mg/m³ at Zieriksee H.W. and L.W., and of 8.9 and 8.9 mg/m³ at Yerseke, H.W. and L.W., thus larger volumes in the western district and the highest figures furthest west. There were this year only slight differences between the H.W. and L.W. samples at station Yerseke. Prolongation of the first plankton bloom in the western district was due to development of dinoflagellates after the usual bloom of pelagic diatoms. The dinoflagellates did penetrate on a limited scale in the eastern district, leading to higher chlorophyll values in June. The chlorophyll increment observed at station Yerseke in February, especially in the L.W. samples, is ascribed to the swirling up by wind of material containing chlorophyll in the shallow eastern section. In late summer and early autumn the amount of net plankton remained remarkably constant at Yerseke at a level of about 5 mg/m³, the H.W. samples preponderating.

The *larger nanoplankton* amounted to an average of 10.2 and 7.7 mg/m³ at Zieriksee and of 7.1 and 5.5 mg/m³ at Yerseke, H.W. and L.W. respectively. The highest values for this fraction were observed in April and May at Zieriksee, the May values being decidedly lower in the L.W. samples. In summer and autumn the level remained remarkably constant here. At station Yerseke, on the other hand, the April bloom was followed by a clear-cut second maximum in July. September did not give another increment; at most a slight indication of it can be observed in the L.W. samples at Zieriksee.

The rapid increment in the quality of the oysters in the western district in September is tentatively associated with the high values for nanoplankton in this area in comparison with the eastern district. At Yerseke, on the other hand, the higher nanoplankton figures in July presumably led to the observed interruption in the decline in condition during the oyster's spawning season.

The *smaller nanoplankton* showed average values of 12.5 and 12.4 mg/m³ at Zieriksee H.W. and L.W. and of 12.9 and 13.3 mg/m³ at Yerseke, H.W. and

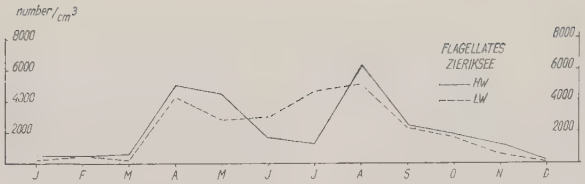

Figure 9. Flagellates, Zieriksee.

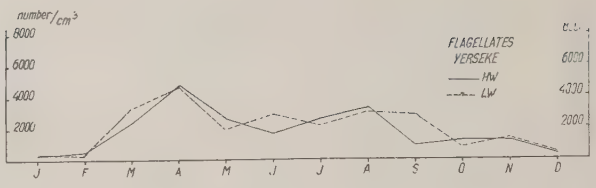

Figure 10. Flagellates, Yerseke.

L.W. There is a marked resemblance with the course for the larger nanoplankton during the summer months, but in March (Yerseke) and again in November (Yerseke and Zieriksee) the fraction of smaller nanoplankton organisms appeared to preponderate noticeably. The rather high values in the L.W. samples at Yerseke in February are ascribed to the swirling up of bottom material containing many small *Navicula*. This tallies with the observation that this increment had no appreciable effect on the level of free phosphates.

It is interesting to note that it was the smaller phytoplankton organisms which initiated the plankton development in the eastern district very early in the year, at a water temperature of only 4°C, but with a solar radiation already amounting to 8,000 cal./cm². Just like in the preceding year, the western district fell clearly behind in this respect, which is tentatively ascribed to its greater depth and turbidity, but the possibility should not be excluded that the unusual salinity pattern also had some influence.

It is noteworthy that the stock of the smaller nanoplankton organisms constitutes the only fraction of the phytoplankton which reveals constantly a higher level in the eastern than in the western district, notwithstanding the greater amount of grazing in the eastern area. The sharper drop in the eastern district in May, as compared with the western district, is tentatively explained in terms of increased grazing brought about by higher water temperatures.

Flagellates

Figures 9 and 10 give an impression of the average number of small flagellates — tiny unicellular coloured and colourless organisms moving about with the aid of flagella — directly observed under the microscope. These flagellates are of considerable importance as food for a variety of zooplankton organisms, including the larvae of many bottom invertebrates. Feeding experiments with oyster larvae have demonstrated that grazing has no doubt an enormous effect on the stock of flagellates.

The number of flagellates rose at station Yerseke already in February, at Zieriksee in March, to reach peak values of about 5,000/cm³ in April at both stations. This tallies very well with the chlorophyll data for the smaller nanoplankton. The course of the flagellate graph for Zieriksee deviates later in the year from the course of the chlorophyll figures, first in the L.W. samples, later also in the H.W. samples. This can be ascribed to a summer increment in the number of colourless flagellates, which could not be detected by chlorophyll measurements. The graph for Zieriksee L.W. runs remarkably parallel to the H.W. graph for Yerseke, but the latter lies at a somewhat lower level.

The yearly averages per cm³ are computed as 2,175 and 2,125 for Zieriksee H.W. and L.W., and as 1,800 and 2,000 for Yerseke H.W. and L.W. It should be stressed that these figures and the graphs in Figures 9 and 10 give only a very general idea of the flagellate stocks. In reality the short-term fluctuations have been far greater than these trends suggest. Grazing by rapidly changing numbers of zooplankton organisms is to be blamed for these sharp fluctuations.

It is noteworthy that the number of flagellates in the eastern district (station Yerseke) has been decidedly lower in the summer of 1958 than in the preceding year. The 5,000-level, considered as good grazing for larvae, has hardly been reached. Hence, the oyster larvae did not develop so well as they did in other summers under similar temperature conditions. The possibility is considered that a lower content of humic substance in the second part of the year is to be blamed for the modest size of the flagellate stock.

Phosphates

The fluctuations in the quantity of phosphates have been recorded in Figures 11 A and 12 A. Special attention has been paid to differentiating the really free phosphates from some very unstable P-compounds usually included in the analysis according to HARVEY. It appeared to be possible to filter off the unstable phosphate compounds, which could be demonstrated to consist at least partly of finely dispersed ferri-phosphate. By sub-

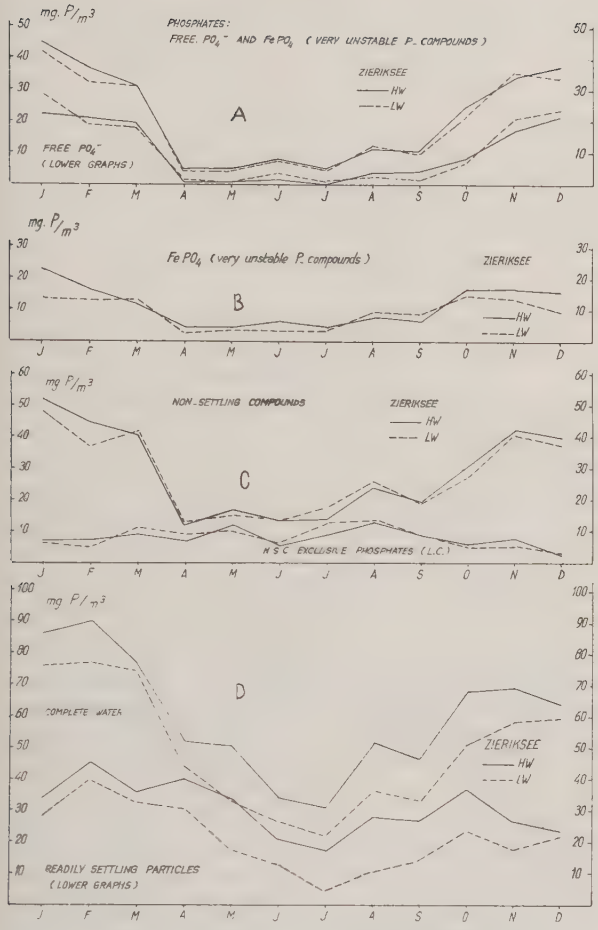

Figure 11. Zieriksee. (A) phosphates; (B) $FePO_4$; (C) non-settling P-compounds, exclusive of PO_4; (D) complete and particulate P.

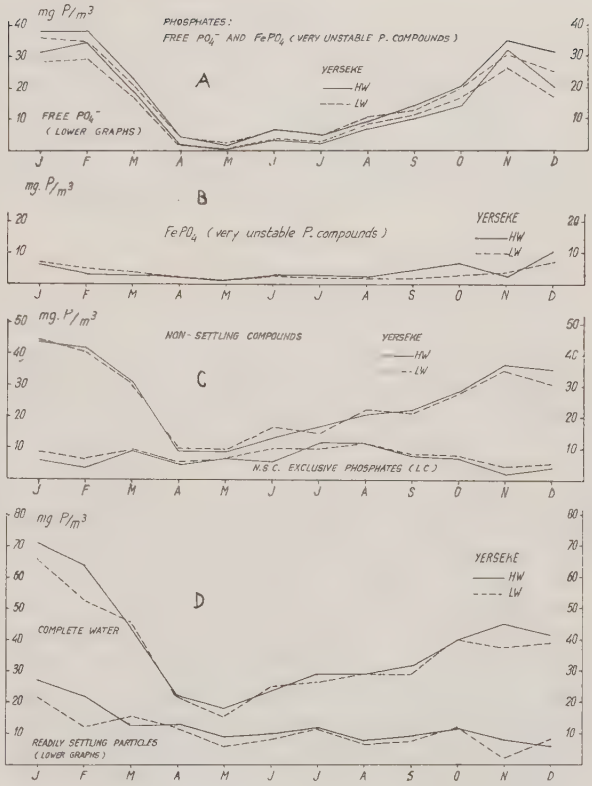

Figure 12. Yerseke. (A) phosphates; (B) $FePO_4$; (C) non-settling P-compounds, exclusive of PO_4; (D) complete and particulate P.

tracting from the total phosphate figures graphs could be presented of the quantities of ferri-phosphate (Figures 11B and 12B). This newly acquired insight should be used in considering and correcting the phosphate data presented earlier.

The phosphate graphs give a very clear picture of the events in the course of the year. The phosphate level dropped commensurately with the phytoplankton development in spring, leading to an almost complete exhaustion of supplies in April (Zieriksee) and May (Yerseke). The fall of the phosphate level at Zieriksee in late winter is not associated with phytoplankton development, but is probably due to a dilution with water masses poorer in phosphate, corresponding with the salinity pattern. The initial level of free phosphates was higher at Yerseke than at Zieriksee; the fact that Zieriksee revealed nevertheless a richer phytoplankton development leads to the supposition that ample supplies of phosphate must have arrived in the western district, partly originating from deeper water layers, partly from the local supply of ferri-phospates.

In the months after the great plankton peak in spring, minor fluctuations in the free phosphate level are rather closely associated with fluctuations in the phytoplankton stocks, as measured by the chlorophyll technique. This indicates that the assumption that phosphate is the main limiting factor in phytoplankton development will not be far from the truth, at least not during the months with ample sunlight. Later in the year, when solar radiation declines, the phosphate levels did increase without leading to new phytoplankton outbursts. It is, however, not yet clear how the phosphate level at Yerseke could rise in late summer without leading to a new phytoplankton bloom. Could it be that another limiting factor has been operating here?

It is very interesting to note that the supply of ferri-phosphate (other unstable P-compounds in

finally dispersed state possibly included) follows the same general trend as the free phosphates. Apparently these compounds do enter into the general pattern of biological production, and should not be considered a dead supply. The high initial level of ferri-phosphate at Zieriksee as compared with Yerseke is significant. This contributed no doubt to the high level of phytoplankton production here.

Organic phosphorus

Again, the non-settling phosphorus compounds were measured by autoclaving water samples with sulphuric acid after sedimentation. By subtracting the phosphate-P one finds a figure for the "organic phosphorus", predominantly in dissolved state, for a minor fraction in very finely dispersed particles. The average values for Zieriksee amounted to 7.9 and 8.1 mg/m³, for Yerseke 6.9 and 8.0 mg/m³, H.W. and L.W. respectively. August gave maxima amounting to 12.7 and 13.7 mg/m³ (Zieriksee) and 11.7 and 11.7 mg/m³ (Yerseke), H.W. and L.W. respectively.

Zieriksee revealed slightly higher figures than in 1957, Yerseke somewhat lower values. The increase in the level of organic phosphorus in the summer months is ascribed to decomposition of phytoplankton. The dilution with Rhine water in early spring may also have been of influence.

The hypothesis that organic phosphorus compounds may favour the development of flagellates, especially of the colourless species, is still maintained. It should be remembered that colourless flagellates reached peak numbers in August, coinciding with top values in organic phosphorus compounds.

Particulate phosphorus

The phosphorus contained in readily settling particles (plankton organisms, detritus, and silt included) was again determined by subtracting the values for non-settling compounds from those for complete water samples. The average figures amounted to 30.8 and 21.2 mg/m³ (Zieriksee) and 12.4 and 10.4 mg/m³ (Yerseke), H.W. and L.W. respectively. It is not easy to offer a sound explanation for the observed fluctuations in particulate P-compounds. That the figures are higher at Zieriksee than at Yerseke — more still than in the preceding year — seems to correspond with the richer plankton in the former station, but upon closer inspection of the data, the differences observed in particulate P are not strictly proportional to the plankton figures. It is further remarkable that the station Zieriksee reveals again a minimum in mid-summer, whereas

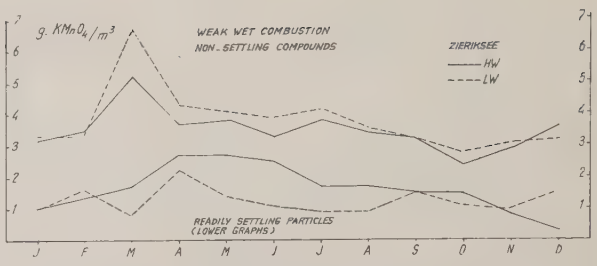

Figure 13. Zieriksee. Weak wet combustion.

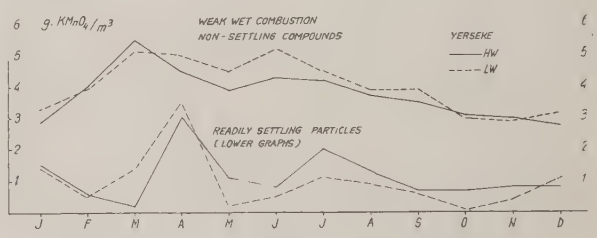

Figure 14. Yerseke. Weak wet combustion.

the values observed at Yerseke remain remarkably constant from April to October. Increased consumption of plankton organisms by bottom invertebrates and fishes in the warmer season will have led to increased fixation of organic phosphorus in these larger creatures escaping our sampling. Late in summer new material will have arrived through increased production of nutrients by bacterial activity, and a subsequent plankton bloom. Another factor affecting the general picture is the swirling up of bottom material by wind and currents. It is surmised that high values observed in winter, when decomposition by bacteria is slowed down, are related to such a swirling up of detritus. Moreover, in the colder months a higher viscosity of the water keeps such particles longer in suspension than in summer. Comparison with the graphs depicting the dry weight of particulate matter demonstrates that these correspond rather closely with the particulate P data: much higher figures for Zieriksee than for Yerseke, and a clear preponderance of H.W. over L.W. at Zieriksee.

Organic matter

Again, the more labile organic compounds have been estimated by means of a weak wet combustion with potassium permanganate, in which the readily settling particles have been differentiated from the non-settling compounds.

The yearly averages expressed in mg of $KMnO_4$ per litre (Figures 13 and 14) amounted to 3.5 and 3.8 (Zieriksee) and 3.8 and 3.0 (Yerseke), H.W. and

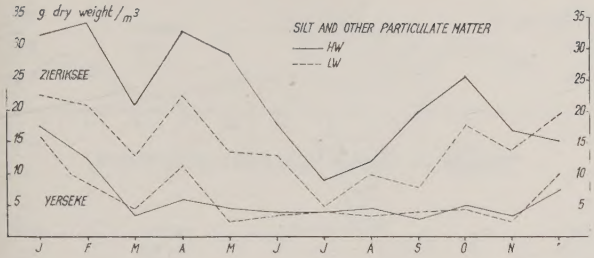

Figure 15. Dry weight of silt at Zieriksee and Yerseke

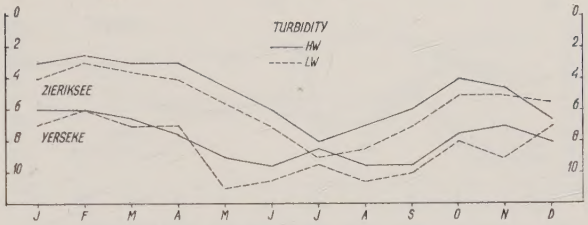

Figure 16. Turbidity at Zieriksee and Yerseke.

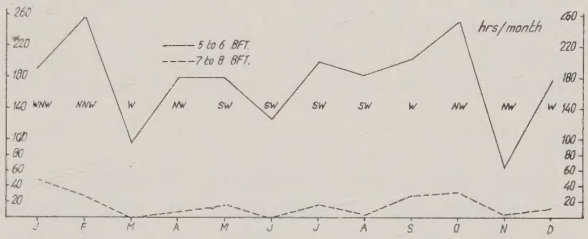

Figure 17. Wind speed, coast of Zealand.

L.W. respectively for the non-settling compounds; to 1.6 and 1.3 (Zieriksee) and 1.1 and 1.0 (Yerseke) for the readily settling material.

It is noteworthy that the level of organic matter was decidedly lower in 1958 than in the preceding year. Further, that the figures for the non-settling material did not run strictly parallel to those for the non-settling organic P-compounds (Figures 11C and 12C). Evidently fluctuations in organic compounds devoid of phosphorus predominated temporarily, e.g. in early spring during the great influx of river water.

The figures for organic matter pertaining to readily settling particles follow, on the other hand, rather closely the phytoplankton data based on chlorophyll extraction.

Dry weight of suspended matter

The average dry weight of the "silt", the total of the particulate matter collected by filtering off water samples, amounted to 22.2 and 14.6 mg/litre (Zieriksee) and 6.2 and 6.4 mg/litre (Yerseke), H.W. and L.W. respectively (Fig. 15).

The eastern district shows slightly lower figures than the preceding year. This can at least partly be explained in terms of the rather quiet weather throughout the year.

Comparison with chlorophyll and phosphorus data reveals that at Zieriksee some 13 mg of the H.W. "silt" and some 7 mg of the L.W. "silt" cannot possibly be ascribed to phytoplankton, whereas only some 5 and 3 mg respectively will have consisted of inanimate matter such as sand. Hence, the quantity of detritus containing phosphorus, but devoid of chlorophyll, was at station Yerseke at H.W. about double that at L.W. This tallies with the 1957 data. The summer minimum (Fig. 15) points to the influence of the factors wind and viscosity.

Turbidity

The relative clarity of the water has been measured with a turbidity meter and with a gauged micro Secchi disk of our own construction. Again, the water was considerably more turbid in the western district, and again Yerseke showed the greatest fluctuations in turbidity (Fig. 16). The graphs for turbidity run rather closely parallel to those for silt content, but there are also some marked discrepancies. The influx of river water in March did lower the silt content, but not the turbidity. Material of humic character may have influenced the turbidity readings.

The greater clarity of the water in the eastern district has presumably contributed to an earlier phytoplankton bloom there, the factor light still being a limiting factor in the deeper more turbid western area at that time of the year.

Wind speed

Since wind appeared to be a factor influencing several items discussed above, it will be useful to add some data on wind velocity collected by the meteorological stations at Vlissingen and Hoek of Holland (Fig. 17). Only wind forces of 8 m/sec. and over (Beaufort 5) are recorded here. Swirling up of bottom material, mentioned for the months of February and October, has evidently some relation with the prevalence of rather strong winds in these months. Periods with lower wind velocity (March, November) clearly affect the values for particulate phosphorus, silt, and organic particulate matter, but neither the chlorophyll data, nor the turbidity of the water.

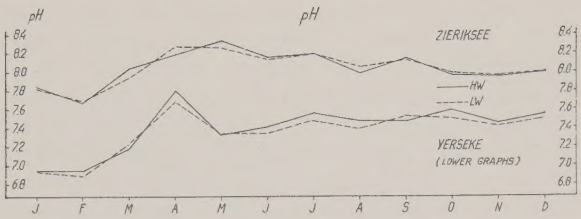

Figure 18. Acidity at Zieriksee and Yerseke.

Stirring up of bottom material usually leads to an increment in the figures for non-settling P-compounds, and if this happens in the warmer season, indirectly to an increment in the phosphate content through the processes of bacterial decomposition.

pH

Again, there was a remarkable difference in the pH between the stations Zieriksee and Yerseke (Fig. 18), the values recorded for the Zieriksee water being considerably higher. The yearly averages were 8.04 and 8.04 (Zieriksee) and 7.40 and 7.34 (Yerseke), H.W. and L.W. respectively.

It is still rather difficult to explain this marked discrepancy. Without doubt several factors are involved in this phenomenon. The rise in temperature is in some cases, but certainly not always, followed by a rise in pH. The influx of river water has evidently exerted a depressing influence on the pH. The subsequent rise in salinity coincided with the rise in pH, but phytoplankton development showed a rapid increment at the same time. To some extent a correlation between pH and phytoplankton development seems a reasonable supposition, but the influence is probably of a rather complex nature. Other factors of influence are presumably respiration by a variety of organisms, plankton included, and shell-formation by molluscs and the like, shifting the rates of various dissolved calcium compounds. It is surmised that the greater density of the invertebrate fauna per volume of water in the eastern district has exerted a considerable influence, leading to the remarkable and constant difference in pH between the western and eastern district.

Specific alkalinity

The alkalinity has been measured according to the method of Anderson and Robinson, with a glass electrode. The specific alkalinity is computed by dividing the alkalinity by the chlorinity. The figures found (Figs. 19 and 20) are rather high, which can be ascribed to the coastal character of the sea water and to the admixture of river water

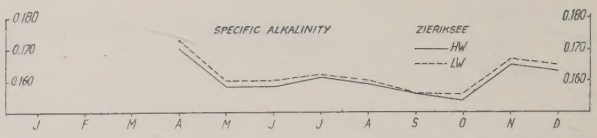

Figure 19. Specific alkalinity at Zieriksee.

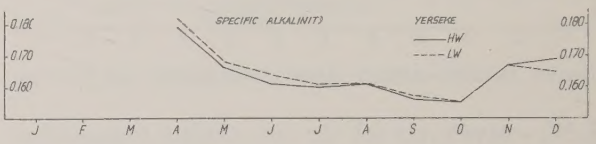

Figure 20. Specific alkalinity at Yerseke.

containing a fair amount of carbonate compounds. The lower values in the warmer season are ascribed to a lesser degree of admixture with river water, and to consumption of calcium carbonate by a variety of shell-bearing organisms. The increased uptake of calcium by the rapidly growing molluscs in the month of September is clearly reflected in the alkalinity figures.

It is of interest to note that the harvesting of mussels and oysters withdraws considerable amounts of calcium compounds from the Oosterschelde, not to return there. New calcium supplies are to be expected from the admixture with sea and river water, from the run-off of the surrounding polderland, and from the 8,000 m^3 of rapidly disintegrating mussel shells scattered on the oyster plots as collectors year after year. We are, however, not yet in a position to present a clear cut balance for the calcium compounds in the Oosterschelde.

Oyster quality

Oyster samples have been collected on a weekly basis since mid-June, at the beginning of the spawning season. The quality of the oysters has again been expressed as a condition index: dry weight of the flesh in grammes divided by the shell cavity expressed in cm^3, times 1,000. The samples analysed consisted of 10 healthy oysters, eventually incubated eggs or larvae included. Incidental analyses of oysters from other plots demonstrate that the observed trend in the course of the season (Figs. 21 and 22) can be considered as characteristic for the oyster population in the entire area.

Food supply, feeding activity, water temperature, and reproductive processes are the main factors involved in determining the fluctuations in oyster quality. The sharp drop in quality brought about by vigorous spawning occurred about a fortnight earlier in the eastern district than in the western. This is tentatively ascribed to the somewhat slower

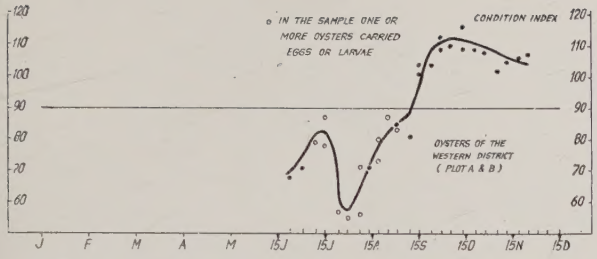

Figure 21. Oyster quality, western district.

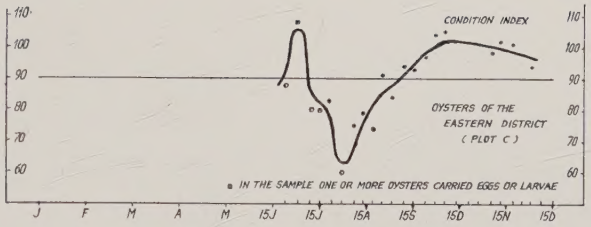

Figure 22. Oyster quality, eastern district.

warming up of the water in the western district, partly also to the after-effects of the unusual admixture with low salinity river water in early spring, which affected the oysters in the western district more than in the eastern. In this respect it is noteworthy that the oysters started the spawning season with a condition index of about 85 in the western district, whereas the initial index was over 100 in the eastern areas. Not all the oysters spawned simultaneously. It is therefore hard to decide whether the obvious interruption of the index decline during the spawning season observed in the eastern district should be ascribed to the counteracting effect of the temporary abundance of food, or to a double-peaked spawning activity. However this may be, the minimum values observed were in both districts an index of about 60, which corresponds with very lean oysters, indeed. Evidently spawning has been more vigorous in the eastern district, leading to a greater loss in condition, than in the western area.

Though some oysters spawned as late as August, a general recuperation was evident at that time, so that the quality index had attained the figure 85 at the end of that month. This figure is, however, still too low for marketable oysters. Fortunately, September saw an excellent supply of oyster food, due to a late phytoplankton bloom. As water temperatures remained fairly high in September, allowing vigorous feeding, the quality index rose rapidly to about 100 in the eastern, and to over 110 in the western district. Later in the year food was less abundant and, since water temperatures did not drop too steeply, metabolic processes led to a gradual levelling off of the oysters' condition in the second part of October and in November. The highest figures were recorded early in October.

Experiments were carried out by suspending oysters attached to baskets of wire netting in several stations in Oosterschelde and adjacent waters. Such oysters were kept well above the bottom at some 2 to 3 metres under the water surface. These oysters attained in general a higher quality index than those grown on the usual oyster plots. Current velocity appeared to exert an appreciable influence in this. Therefore special attention will be paid to this factor in the years to come.

Postscript

The unusually strong influx of river water in early spring, when water temperatures were still very low, did not lead to a noticeable mortality among the oysters, though it did strongly affect the starfish population.

Depletion of phosphate limited the primary production of phytoplankton in late spring and early summer. The oysters' condition dropped sharply in summer through vigorous spawning. A rapid recuperation was favoured by a timely secondary bloom of phytoplankton, leading to higher condition indices in the western than in the eastern district.

The detailed studies of food and feeding conditions in the oyster district are carried out to increase our knowledge on oyster culture. This is an urgent matter, for in all probability the Oosterschelde will be cut off from the sea when the so-called Delta Plan approaches its completion. Efforts will be made to create an artificial basin for oyster culture. To provide the oysters in such a basin with the best possible conditions for growth and fattening it is necessary to collect as much information as possible on the various factors involved, in order to frame shape and general conditions of the artificial basin in such a way that a remunerative oyster culture will be possible there.

A. C. Drinkwaard